PRODUCT ENGINEERING

For Engineers and Executives Responsible for Product Creation, Design and Improvement

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JANUARY, 1932 VOL. 3, NO. 1

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Member A.B.C.
10,000 copies printed this issue
8,628 paid subscribers,
December 15, 1931

Published monthly. $2 per year. 25 cents per copy. Canada, $3.50, including duty. Foreign, $4.00 U. S. currency, or 20 shillings. Entered as second-class matter, January 17, 1930, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

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McGraw-Hill Publishing Company, Inc.
330 WEST 42d STREET, NEW YORK, N. Y.
Cable Address: "MCGRAWHILL, N. Y."

CHICAGO - 520 North Michigan Avenue
SAN FRANCISCO - 883 Mission Street
LONDON, W. C. 2, Aldwych House, Aldwych

Washington - - - National Press Building
Philadelphia - - - - - 1600 Arch Street
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We wish you a happy and much more prosperous New Year. May it be a year of opportunities grasped, of responsibility accepted, of success attained; and may the rewards and the recognition of the engineer be commensurate with his contribution to the general well-being.

For the staff—

K. H. CONDIT,

Publishing Director

PRODUCT ENGINEERING

MCGRAW-HILL PUBLISHING CO., INC. VOLUME THREE, NUMBER ONE

JANUARY, 1932

Minimizing Lost Motion in Mechanical Transmissions

By WALTER M. POHL

Assistant Chief Engineer,
Kearney & Trecker Corporation

A method of analyzing the backlash for each element of the train, and its effect at the driven end, to enable the engineer so to arrange the units that there will be the least total lost motion

IF IT is found, after a machine has been completed, that there is an excessive amount of backlash or free play in the transmission train, the first impulse of the engineer is to place the blame on shop workmanship. It should be obvious, of course, that the specifying of close tolerances and minimum clearances alone will not avoid backlash. Backlash results from the clearance allowed between contacting surfaces in gears, jaw clutches, splines and similar machine elements.

The value of this backlash allowance, which will be designated by K, depends largely on the dimensions, type of free contact employed, and class of workmanship. Its magnitude will be practically constant regardless of the size of the machine element. However, the amount of angular rotation permitted by the backlash will be inversely proportional to the pitch radius of the gear or the radius to the contacting surfaces in the case of elements such as splines. Using the term "backlash factor" for the amount of rotational free play, and expressing this rotation as a radians, we have the relation that the backlash factor in radians is the backlash allowance K divided by the radius distance r to the contacting surface. That is:

$$a = \frac{K}{r}$$

The ultimate free movement produced at the output shaft will be the backlash factor multiplied by the ratio of the speed of the output shaft to the speed of the shaft at which the backlash factor is measured. Calling this speed ratio G, the backlash A at the output shaft will be: $A = \frac{GK.}{r}$ It is evident that in speed reductions the backlash is reduced, whereas with speed increases the backlash is increased.

The accumulated lost motion in a gear train or a train of linkages is found by treating each element separately and adding the backlash factors as calculated for the output shaft.

In an actual machine the tolerances will be found to vary over a wide range, according to shop standards of accuracy, chance assembly of related parts, and the like. The backlash factor does, however, give a definite standard whereby two or more systems or arrangements of transmission can be compared. For the purposes of

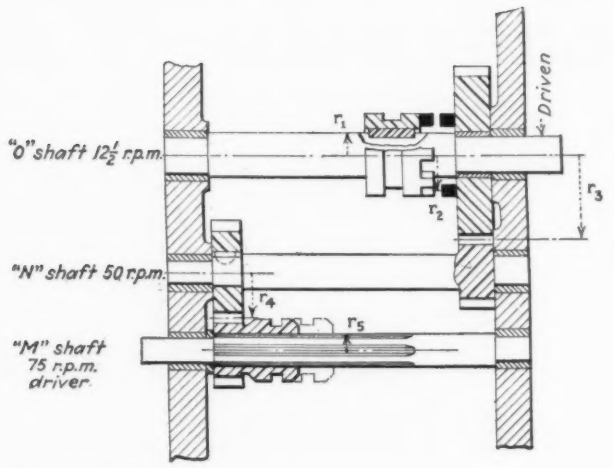


Fig. 1—Three free contacts at the output or reference shaft *O* account for most of the high backlash factor of this system

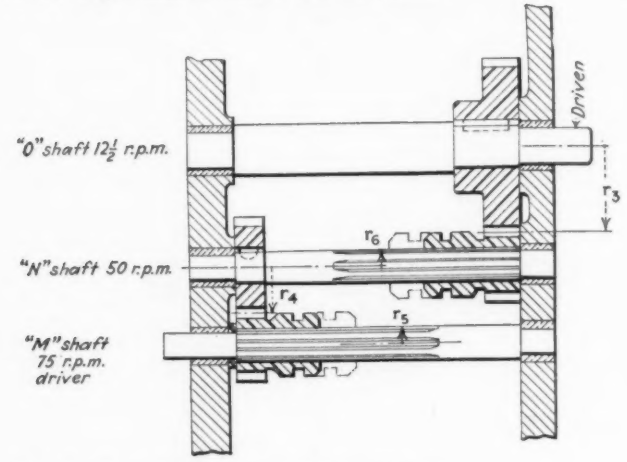


Fig. 2—By substituting a sliding gear on the intermediate shaft for the square-jaw clutch on the output shaft, Fig. 1, inherent backlash of the system is reduced 72 per cent

illustration, the following average values of K will be assumed. They are obtainable by ordinary good workmanship:

$K_1 = 0.002$ in. for splines
$K_2 = 0.003$ in. for gears
$K_3 = 0.005$ in. for square-tooth clutches

To illustrate the application of an analysis of backlash, let us compare the backlash factors of the gear trains in Figs. 1 and 2. It should be kept in mind that any gear contact can be measured from either driver or driven axis with results exactly the same as long as the gear ratio from the particular axis is used. In any case, only one contact can be accounted for in any one pair of gears. For convenience and clarity the data are arranged in tabular form.

For the examples under consideration, the following physical dimensions will be assumed:

$r_1 = 0.75$ in. $\quad r_3 = 4.0$ in. $\quad r_5 = 0.6$ in.
$r_2 = 1.50$ in. $\quad r_4 = 2.5$ in. $\quad r_6 = 0.937$ in.

Referring to Fig. 1, at the driven shaft *O* there are three free contacts, a gear, a spline, and a clutch contact. As this is the shaft to which the backlash factor is being referred, there is no shaft ratio to be taken into account, and the backlash factor for each is simply K/r. These values are entered in Table I for shaft *O* under the respective classification of type of contact.

Shaft *N* has two free contacts, one of which already has been accounted for on shaft *O*, so that only the gear with radius r_4 need be considered. The algebraic ratio of shaft *N* to *O* is 12.5/50 or 0.25 (not 4). Hence in this case,

$$A = \frac{GK}{r} = \frac{0.25 \times 0.003}{2.50} = 0.0003 \text{ radians}$$

Shaft *M* has an additional spline contact at radius r_5. Its algebraic ratio is 12.5/75 or 0.166, and the corresponding backlash factor:

$$A = \frac{0.166 \times 0.002}{0.60} = 0.00055$$

Totaling the columns (Table I), for gears, splines and clutch, the summation is found to be 0.00760, the backlash factor for the system. The factor for gears represents 13.8 per cent of the total, splines, 42.5 and clutches 43.7 per cent. In fact, the spline contact at shaft *O* alone is respon-

Table I—Backlash Factors for Gear Train Shown in Fig. 1

Shaft Sym.	Algebraic Ratio G	$\frac{G}{r} \times K_2$ Gears	$\frac{G}{r} \times K_1$ Slid Splines	$\frac{G}{r} \times K_3$ Clutches
O	1.	$\frac{G}{r_3}$ 0.00075	$\frac{G}{r_1}$ 0.002666	$\frac{G}{r_2}$ 0.00333
N	0.25	$\frac{G}{r_4}$ 0.0003	.....	.....
M	0.166	.....	$\frac{G}{r_5}$ 0.000554	.....
Total	.....	0.00105	0.003220	0.00333

Grand Total 0.0076

Table II—Backlash Factors for Gear Train Shown in Fig. 2

Shaft Sym.	Algebraic Ratio G	$\frac{G}{r} \times K_2$ Gears	$\frac{G}{r} \times K_1$ Slid Splines	$\frac{G}{r} \times K_3$ Clutches
O	1.	$\frac{G}{r_3}$ 0.00075	.....	.....
N	0.25	$\frac{G}{r_4}$ 0.0003	$\frac{G}{r_5}$ 0.000532	.....
M	0.166	.....	$\frac{G}{r_5}$ 0.000554	.....
Total	.....	0.00105	0.001086	.....

Grand Total 0.002136

sible for 35 per cent of the total backlash factor. This at once suggests the point at which greatest saving in backlash can be made.

In Fig. 2 is shown a transmission in which considerable improvement in backlash is obtained. The train is identical with that shown in Fig. 1, except that the clutch on O is eliminated, and clutch action is accomplished by the sliding gear on shaft N. The new factor introduced is the spline shaft with radius r_6, but the number of contacts on shaft O has been reduced from three to one. Recalculating in Table II, we find a total backlash factor of 0.002136, or 28 per cent of the first system, indicating a reduction in inherent design looseness of 72 per cent.

With the circular measure in radians as a basis, the backlash factor, with K and r in inches, is also equal to inches backlash at 1-in. radius. That is to say, the total factor in Table I equals 0.00760 in. at 1-in. radius, or 0.0760 at 10-in. radius.

Fig. 3 shows a train with few gear contacts but a high backlash factor owing to the high number of sliding keys and clutch contacts and the low ratio to the output shaft. Such a drive would be very undesirable with pulsating loads and low speeds, as in milling and gear-cutting machines.

It was in connection with a study of transmission trains in milling machines that the backlash factor was developed. Some of the problems encountered will illustrate additional design principles that have application in wider fields.

In the analysis of milling, the cutter removes wedge-shaped sections of metal. Neglecting inertia for the moment, the force necessary to shear the chip section is built up by the torsional deflection of the various shafts, which momentarily causes a lag in the velocity, or what is commonly known as wind-up. As a chip is about to break through, the energy stored by reason of deflection

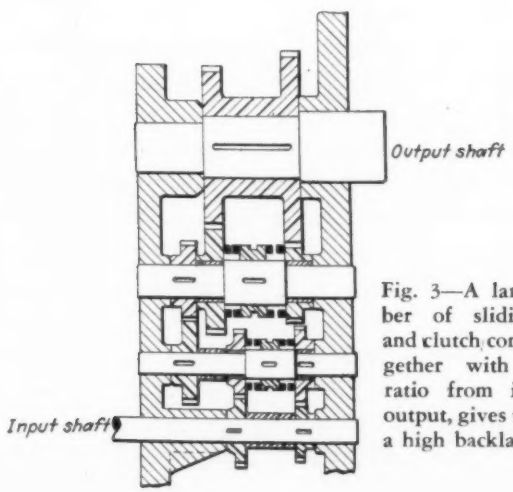


Fig. 3—A large number of sliding keys and clutch contacts, together with a low ratio from input to output, gives this train a high backlash factor

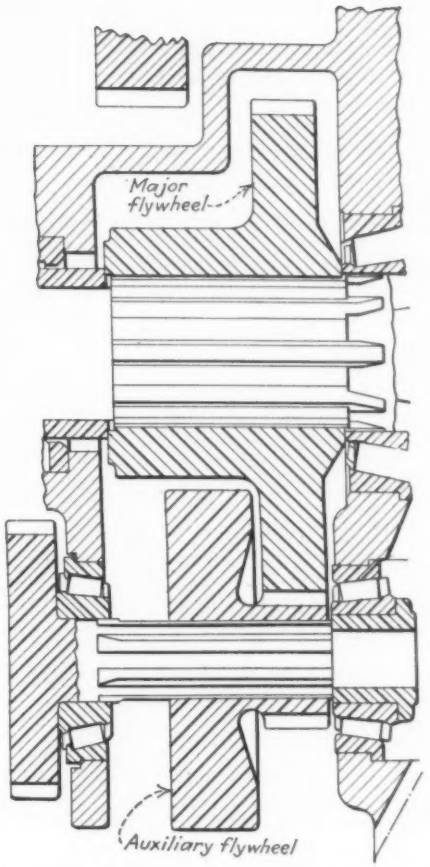


Fig. 4—In order to render effective an auxiliary flywheel, backlash conditions must be reduced to a minimum

and force in the driving members is allowed to restore itself, with consequent overrun, or lead, in the velocity. This momentary lag or lead in the velocity causes lost motion to be taken up first in one direction and then in the other, which, to distinguish it from vibration, will be called "clatter."

To reduce this clatter sufficiently, a relatively large amount of stored energy must be available at the spindle. It is best supplied by a flywheel mounted directly on the spindle with no intervention of lost motion or flexibility between source and consumption of energy. At moderate and low speeds the required size flywheel, however, is often impractical because of its necessarily mammoth proportions. As a result, the cutting impulses are transferred as far back as the motor armature before sufficient accumulated stored energy is available. A condition such as this coupled with a high backlash factor, is bound to result in chatter and unsatisfactory workmanship, regardless of the rigidity of the supporting structure, since the essence of the problem is torsional rather than lateral vibration.

With the demand for wide ranges of speed for machine tools, the correlation of stored energy

and backlash factor must be well balanced to insure maximum production and cutter life, with minimum chatter and vibration. The fallacy of incorporating the flywheel at the ideal location with inadequate size or value is common, and it shows that the quantitative value necessary to properly minimize cutting impulses has been underestimated.

One solution is to provide an auxiliary flywheel mounted on an adjoining higher velocity shaft, as in Fig. 4. This is of great value in concentrating stored energy in a minimum space close to the spindle. Although one gear contact intervenes, it is of low backlash factor and detracts only slightly from the large gain in referred effective inertia at the spindle. This additional flywheel, though relatively small in comparison to the major wheel, nevertheless has a high capacity owing to its greater velocity, since the kinetic energy of a given body varies as the square of the speed.

Obviously, the success of the auxiliary wheel depends largely, if not entirely, on the degree of rigidity and lost motion. Flexibility introduced between the two flywheels, as of an intermediate shaft, lowers the torsional vibrating frequency and increases the amplitude of the auxiliary flywheel and shaft to such an extent that severe out-of-phase or nonsynchronized action of the flywheel will result. Instead of aiding the major flywheel, it will, at certain periods of the cycle, oppose the effect of the former.

In gear-hobbing machines the backlash factor is also of vital importance in maintaining synchronism and consequent accurate work. Provision of the self-locking worm for index drive does not necessarily mean that the backlash factor of the preceding train can be ignored, or that lost motion has been eliminated. A high factor between hob and index table still allows leading of the hob velocity, or so-called overrun.

Unnecessary Accuracy

ENGINEERS are supposed to know that the costs of manufacturing operations increase rapidly with the degree of accuracy specified. But it is evident that quite a few engineers lose sight of this fact and that some of them do not appreciate the high cost resulting from specifying tolerances smaller than commercial requirements. The following paragraphs were received from the engineer of one of the leading manufacturers of precision tools and parts.

One of the major benefits of the present standardization movement which is extending into many industrial fields is the establishment of practical and workable limits on manufactured parts and tools. But despite rapid progress, a tendency to specify limits that are not only unreasonable, but unnecessary and even impossible, still prevails among some engineers and drawing room staffs.

Not long ago an inquiry reached several manufacturers calling for a bid on certain tools having an irregular outline that could not be ground or otherwise corrected after the hardening treatment. The print sent with the inquiry called for a maximum of 0.0005 in. from the specified outline of the part to be made by the tools, and also called for the tools to be made of high-speed steel.

Most of the manufacturers who had been requested to quote declined to do so on the ground that they would not care to be committed to the maintenance of this degree of accuracy throughout the active life of the tools. Subsequent investigation disclosed that the part to be produced with these tools did not require great precision in outline and the result of the unnecessary closeness of the limits called for was that the purchaser limited his source of supply for the needed equipment, thereby depriving himself of the advantages of competitive bidding and designing.

This same investigation indicated that the purchaser was not getting the accuracy demanded by his prints and that tools made within more reasonable limits were being accepted by the factory because they knew that the limits called for by the engineering department were not essential.

It may be that some of the men who so readily put down limits in tenths of thousandths on paper have practically no conception of their meaning. While limits are necessary on most manufactured parts and particularly necessary on parts that are to be interchangeable, unnecessarily exacting tolerances are a source of expense without any compensating advantage. It is sound engineering practice to specify the largest limits that are consistent with the satisfactory functioning of the part to be manufactured and there is no better time than now to see that unnecessarily close tolerances are not required.

Trends in Product Engineering

Many individual design changes considered together constitute a trend—and with such trends the engineer must keep in touch. Here are summarized recent important engineering developments in many fields

STANDARDIZATION and interchangeability of parts has been highly developed in the Crompton & Knowles line of "Super" silk looms. The same frame design is used on 82 per cent of all the silk looms manufactured by this company. Not only parts, but entire motions, are interchangeable. Revision from plain to roller bearings, from non-automatic to automatic, and from one combination of boxes to another is thus facilitated. Loom frameweight has been increased for added stability. All lengthwise members are structural steel. Motor frame is of the three-point suspension type. Bearings for crank, bottom, and rocker shafts are of the cartridge type, housed in the loomside. Brake and shipper handles are at each end of the machine. A new batwing motion is employed in picking. The picking shoe has a long sweep and imparts constant acceleration to the shuttle.

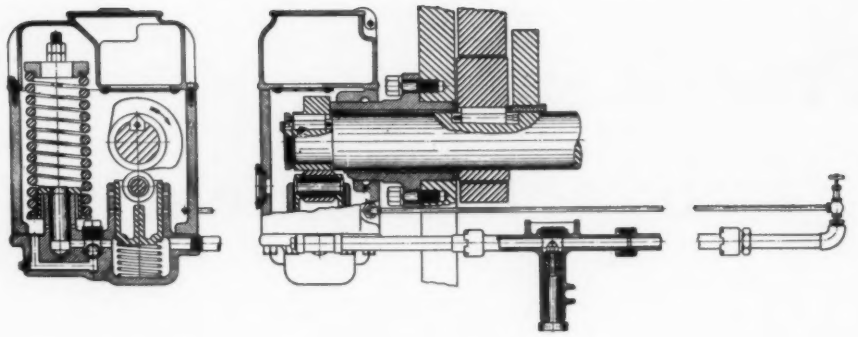
High-Speed Tapping Machine

Tapping speeds to 2,300 r.p.m. are claimed for the new Haskins tapping machine. There is no radial float in the tapping head and the spindle and tap holder are of small size and low weight so that inertia effects are minimized. A constant speed, repulsion-induction motor drives the spindle through a pair of gears. Final chuck drive is through a double cone clutch faced with cork. Reverse at double the forward speed is by a planetary gear train with three fixed planets and a rotating ring gear carried on the cup end of the drive shaft.

Hydraulic Woodworking Drill

Hydraulic feeds are finding their way into woodworking machinery. In the Root multiple boring machine, drill heads are stationary and platen feed is by hydraulic piston and cylinder, the

BALANCING the dipper with a movable counterweight permits a larger dipper and higher operating speed for the same electrical equipment in a given-sized Bucyrus-Erie stripping shovel



SECTION of the master hydraulic cylinder and its connection to one of the 10 hold-down plungers on a Cincinnati shear. A cam on the shear eccentric shaft end actuates the master piston, thus forcing oil to the hold-downs for the desired period. This provides even clamping regardless of sheet thickness. Clamping pressure is variable up to 2,000 lb. per hold-down by setting nuts on the accumulator

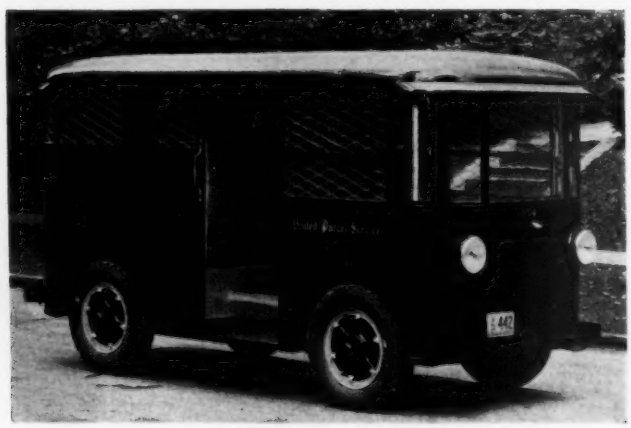
latter mounted on the base. A motor-driven gear pump supplies hydraulic power, manually controlled through a double treadle-operated valve; or the table can be reciprocated continuously up to 30 strokes per minute by means of stop controls. Spindles are driven independently from a single main drive shaft through universal joints and telescopic shafts, to make spindle spacing adjustable, as is common in metal-working drilling machines.

Cabin Autogiro

The first autogiro equipped with a cabin structure has been flown in England. The new English machine, which seats two persons, has a three-bladed rotor or revolving vane and folding rotor blades to permit its storage in a constricted space. The use of only three vanes on the rotor is new.

V-Belt Drive for Deep Well Pump

A short-center V-belt drive from gas engine to vertical-shaft deep-well pump, such as used for irrigation, is now being applied. The standard LeRoi internal-combustion engine used operates on natural gas fuel and incorporates a built-in right-angle drive consisting of a pair of alloy-steel spiral bevel miter gears, heat-treated and ground, carried on ball bearing shafts. Belt pull is centered directly over the top bearing. Remote hand control or full automatic tank float control can be used through an electric starter and automatic centrifugal clutch. Water temperature and oil-pressure safety cutouts are provided.



BODY and underframe of this Twin Coach delivery auto are integral. The body, extending beyond front and rear axles, acts as a box beam, resulting in a low platform and roomy interior. Other features are single pedal and single lever, either of which control both clutch and brake

Liquid and Glas Flow Meter

The Rotameter, a simple form of liquid and gas flow meter, introduced from Germany by Schutte & Koerting Co., consists of a slightly tapered vertical glass tube with a bullet-shaped float. The flow of gas is from the small end of the tube bottom through the annular opening around the float, flow rate being indicated by the height of the float.

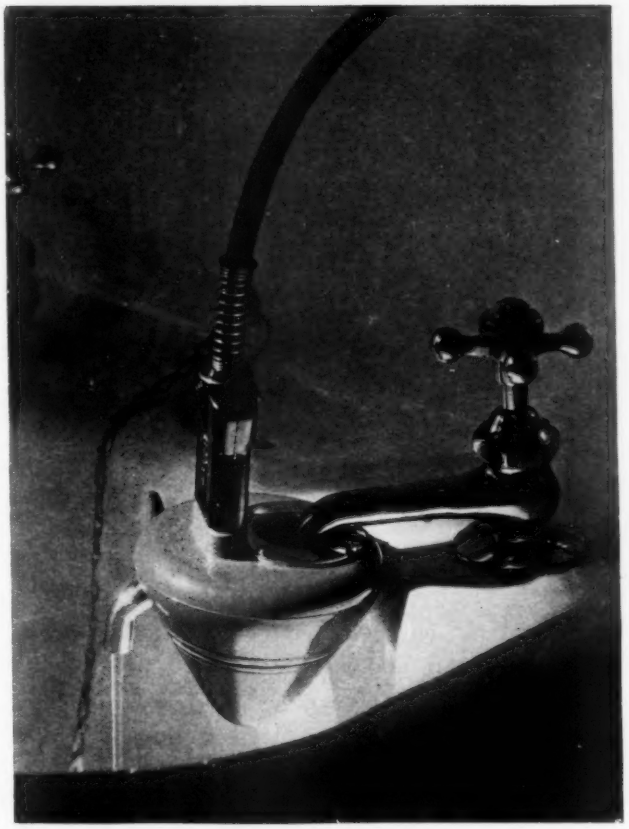
Steamship Funnels

Stern discharge of engine exhaust in speed boats and racing craft has permitted clearer decks and better deck conditions. This principle may be adapted to ocean liners if engineers find it feasible. Removal of stacks from the decks would increase passenger comfort and would provide a long sweep of clear deck not previously attainable. It would also permit a passenger liner to be quickly converted into an aircraft carrier.

Chrysler, anticipating a trend to small standardized cruisers and high-speed runabouts, has developed the Regal marine engine. Of the 4-cyl. type, the unit develops 55 hp. at 2,800 r.p.m. A rubber-cushioned mounting, built integral, requires no change in the engine bed.

Jacketed Pipe and Fittings

Elimination of all bypassing around fittings in steam jacketed lines for the conveyance of materials which must be held at an elevated temperature is claimed for a new design of jacketed pipe fittings and valves announced by Guyton & Cumfer Mfg. Co. The method employs standard pipe. The inner pipe, used to convey the material, is threaded into the special coupling, while the outer pipe, used to convey the steam or other heating medium, is secured by a packing gland that provides for unequal expansion.



SOFT RUBBER and Durez, a molded plastic, find new uses in this electric water heater, designed to product hot water instantaneously at 2 qt. per minute. The plastic is available in a variety of colors, and a soft-rubber grip seal holds the unit on the faucet

Insulated Coal Range

Dr. Gustaf Dalén, Swedish inventor, has developed an insulated cooking range, the AGA cooker, which maintains constant temperature on 8 lb. of coke or small-size anthracite per day. Economy, secured through thermostatic damper control and scientific insulation, coupled with attractive design and finish, has produced satisfactory sales in Sweden and England in spite of relatively high first cost. Temperatures on the two hot plates are 750 and 480 deg. F., respectively, and in the two ovens 480 and 200 deg., respectively. Insulating covers protect the hot plates when not in use, and the cooler oven is an effective "fireless cooker." A water-heating chamber is incorporated.

Coal Dust Motors

Coal dust may be used to run internal combustion engines of the Diesel type, according to Rudolph Pawlikowski of Gorlitz, Germany. He has developed motors of 600 hp. and larger, and explains that a variety of other cheap fuels may be used just as well, including sawdust, the vegetable powders from palm kernels, sunflower seed, rape, hemp, peanuts and soy beans. Incidentally, Dr. Diesel's primary object in the development of his engines was to use coal dust.

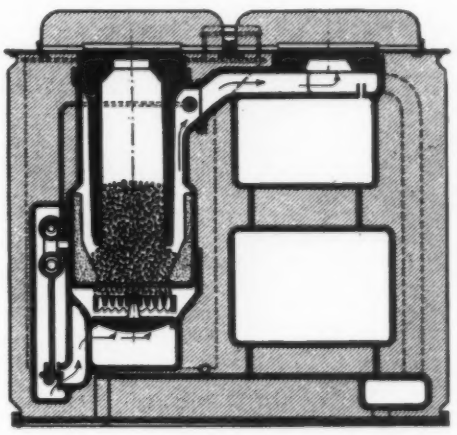
Eighteen British makers are showing oil-engine driven trucks at the Olympia exhibition. Last year, all were gasoline driven.

Stainless Steel Drying Cylinders

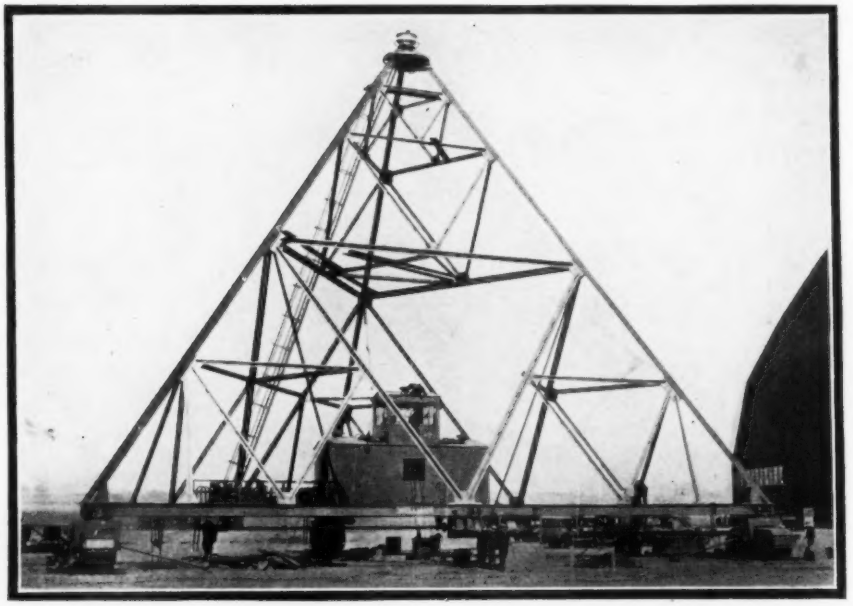
Stainless steel finds another use in drying cages for spinning machines in the Furness process for manufacturing cuprammonium yarn. Each drying cylinder is 8 in. in diameter, is built up of 28 stainless steel rods, 38 in. long, and its axis is set 13 deg. to the horizontal. As the cylinder revolves, alternate rods are raised and depressed slightly, thus carrying the yarn upward along the cylinder in a helical manner, while the acid runs down in the opposite direction.

Sterling Silver Typewriters

L. C. Smith & Corona Typewriter engineers found that one way to get additional portable typewriter business was to bring out something brand new. Accordingly, they designed a portable unit combining Smith construction and Corona style, the idea being to give the typewriter new atmosphere along with new "dress." A silver background was decided upon for atmosphere and a silver medallion was put on each machine as a hallmark. The company then decided to have Gorham make a sterling silver typewriter for the high spot of a dealer's window display and also designed a special leather combination carrying case and week-end bag. When the machine was displayed, it was found that possible purchasers were very much interested in buying the sterling silver machine itself. The result has been factory-swamping orders and the introduction of typewriter selling into jewelry stores.



MAGAZINE FIRING, complete insulation and thermostatic oven temperature control feature this new coal-burning AGA range



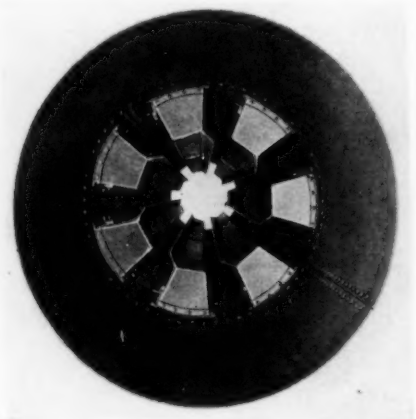
TRIPOD mooring mast for the U.S.S. Akron. Motor-driven caterpillars on two legs provide traction, on the third, direction. A 250-hp. gasoline engine driving a 125-kw. d.c. generator is incorporated to provide power, used also for the winch and fuel and water supply pumps. Control of all functions is centralized in the pilot's cabin above the motor-generator room

Ford Passenger Buses

The Ford Motor Co. is entering the passenger bus field with a 21-passenger low-cost bus built on the Ford AA truck chassis. Body construction is all-steel. The driver's door is at the left, as usual, and a rear emergency door is operated from either inside or outside. The twelve safety-glass windows lower flush with the sills and are operated by crank-type window regulators. Inside dimensions are 76x169 in., head room, 66 in.

Remote Control Bin Gate

Remote control bin gates designed by the Stephens-Adamson Manufacturing Company consist of throat casting, counterweighted valve plate to close the opening, and two latch mechanisms operated by a General Electric "Thrustor." The valve plate is held closed by the front latch. Pressing the remote control button causes the "Thrustor" to open the latch, and, assisted by the weight of the load, the "Thrustor" opens the valve or gate. A second push on the remote control button causes the "Thrustor" to open the rear latch, the counterweight on the valve casting then causing it to move into the closed position, where it is locked by the front latch.



REPLACING the customary central tube by specially shaped box-like conduits increased Louisville rotary dryer efficiency 5 per cent to 85.5. Flights on the conduits lift and cascade the material while the gases pass through the tubes and back through the shell

Color Index

Blue, after fifteen months of relegation, has resumed leadership as the most popular automobile hue, according to the DuPont Automobile Color Index. Green, black, brown, gray and maroon follow in importance in the order indicated. Blue's current trend indicates possibilities of a further advance in the near future partially due to the addition of four additional blues. The importance of green as an automotive finish has more than doubled since June, but green is now showing evidences of nearing a peak. Greens seem to have a shorter tenure of appeal than blues over a period of time. The beginning of the decline of black's popularity as an automotive finish has been alluded to for several months.

Electrical Equipment

Trends in general electrical equipment, as summarized by *Electrical World,* include: Further advances in design of lighting sources of the Neon-tube type have resulted in their increased use for decorative lighting. It is becoming more and more common to use motors of the dust-proof type with integral inclosed air circulating systems. Also of increasing importance are motors having built-in gear reduction units. Further use is being made of Thyraton control and photo-electric relays in order to obtain higher speeds in repetitive operation.

Bearings for Spindles Transmitting Impact Loads

In shafts where the torque delivered throughout a revolution fluctuates greatly, the bearing load as calculated from the horsepower transmitted must be multiplied by a factor to determine the maximum radial bearing load. The author explains how this factor is obtained for woodworking machine cutterheads. The same method is applicable of course to other shafts similarly loaded

By DAVID B. TURCOTT
Mechanical Engineer

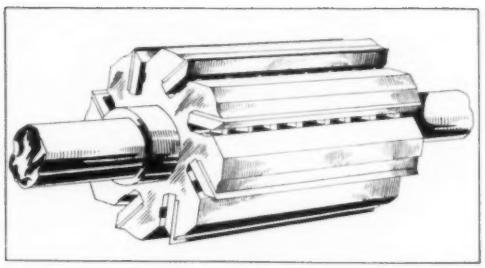


Fig. 1—Multi-knife round cutterhead generally used in planers, matchers, and heavy surfaces

MANY AN engineer will recall the discouraging and sometimes mystifying failures accompanying the first applications of anti-friction bearings to woodworking machinery. Today, thanks to intelligent engineering analysis, this type of bearing is standard for high-speed cutterhead spindles. The analysis proved that greater precision in the bearings themselves, and far greater accuracy in the mounting than was at first though necessary, would solve the problem. Yet there is still much to be done in developing the principles governing the selection of the bearing size.

Capacity ratings as given by the manufacturers form the basis for the selection of the bearing size. Manufacturers' ratings represent the safe allowable loads the bearings can carry under certain given operating conditions. The basic rating must then be modified to determine the correct capacity required to meet the actual operating conditions. The modifying factor depends primarily upon the speed and power delivered to the spindles, operating conditions, and the maximum bearing load imposed. The factor must be established by the engineer.

Little information has been accumulated as to the power required to cut wood. The difficulty of estimating such power requirements is because of the many variables that must be considered. Wood is not a homogeneous material, and no two pieces of stock are alike. Furthermore, the power required depends upon the rate of feed, width of cut, depth of cut, the angle of the knife and the condition of the cutter. There is a lack of data on which to establish a rational basis for estimating horsepower consumption in woodworking machines. Yet in spite of all this, designers of woodworking machinery have accumulated sufficient experience to enable them to approximate average horsepower requirements for specific work. On the basis of these horsepower requirements, the bearing loads can be determined.

For determining bearing loads, the work done by the woodworking cutterhead and the type of cutterhead used must be considered. In Fig. 1 is shown a typical multi-knife round cutterhead generally used in planers, matchers, and heavy sur-

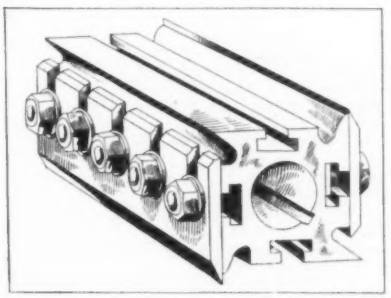


Fig. 2—Cutterhead with two knives for straight planing. For heavy moulder work, special work, or short runs, only one knife might be used

facers. Such cutterheads are built with from four to fourteen knives. On the other hand, a cutterhead such as shown in Fig. 2 may have only two knives when straight planing is done, or even only one knife for heavy moulder work, special work, or short runs. When only one knife is used for cutting, another knife is bolted to the opposite side of the cutterhead merely for balance. When

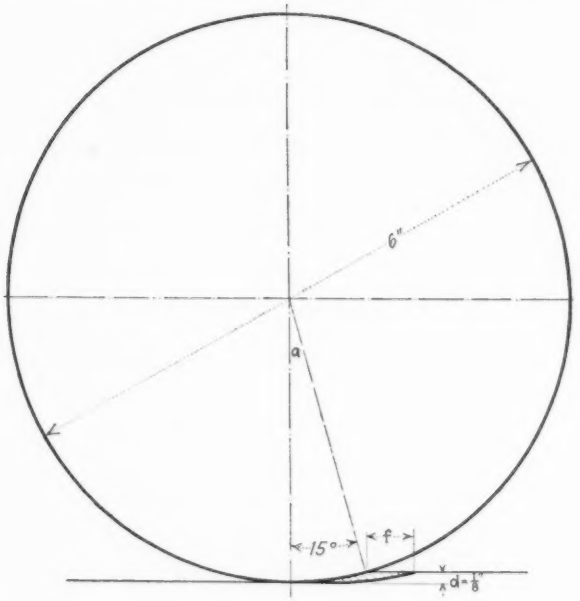


Fig. 3—Diagram showing a 6-in. cutterhead taking a shallow cut, all the work being done while rotating through an angle of only 15 deg.

heavy cuts are taken with only one knife doing the work, there is considerable pounding set up by the impact. There is also vibration on account of the lack of perfect balance in such a cutterhead. The impact and vibration impose a heavy load on the bearings.

Another factor is that the total load is practically never equally divided between the two bearings. In a planer and matcher the stock is fed next to the guide and travels in contact with the guide. The guide bar being near the right hand bearing, that bearing takes the major portion of the load. Similarly, wide surfacers, say 30 in. wide, may take narrow boards alternately on the right side and left side of the cutterhead, thus imposing the full load first on one bearing and then the other.

On account of the non-uniform distribution of loads, it is safe to assume that the full load must be carried by one bearing. Therefore, in a surfacer both bearings should be of equal size. Planers, matchers and molders having the guide near the right hand bearing facing the feed end of the machine, should have the right hand bearing of ample capacity to carry the full load while the left hand bearing might be slightly smaller. The narrower the average run of work as compared to the total width of the molder or planer-matcher cutterhead, the smaller can be the bearing on the left side of the machine, away from the guide.

In arriving at the bearing loads the most important factors are the depth of cut, the number of knives, and the diameter of the cutting circle. Let it be assumed that the cutterhead for which the bearing loads are to be figured is similar to the one shown in Fig. 1 and has the following specifications:

Diameter of cutting circle—6 in.
Number of knives—4
Revolutions per minute—3,500
Maximum horsepower transmitted—20
Depth of cut—$\frac{1}{8}$ in.

Let it be assumed that the width of cut and the rate of feed is such that 20 hp. is required. The mean tangential force at the cutterhead can then be calculated from the following formula:

$$F = \frac{33{,}000 \text{ hp.}}{\pi D S}$$

F=mean tangential force in lb.
$hp.$=horsepower
D=diameter of cutting circle in feet
S=r.p.m.

For the cutterhead under consideration, the mean tangential force will be:

$$F = \frac{33{,}000 \times 20}{3.14 \times 0.5 \times 3{,}500} = 120 \text{ lb.}$$

By referring to Figs. 3 and 4, which represent a diagrammatic view of a shallow and a deep cut respectively, using a cutterhead 6-in. in diameter,

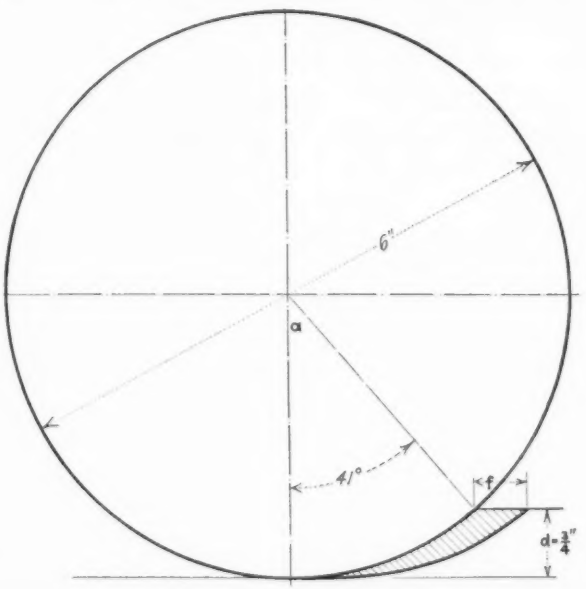


Fig. 4—A 6-in. cutterhead, with the same feed as shown in Fig. 3, taking a $\frac{3}{4}$-in. cut. The angle during cutting has increased to 41 deg.

we see that the angle a in which all the cutting is done, varies greatly with the depth of cut. Let f represent the feed per knife, while d is the depth of cut, the shaded portion in the figure representing the chip removed by one knife. This chip starts infinitely thin and the thickness gradually increases to a maximum at the end of the cut.

For the 6-in. diameter cutting circle, and cutting to a depth of ⅛ in., the angle a is 15 deg. In other words, the knife remains in the cut 15/360 or 1/24 of a revolution. Representing this ratio by the latter r, we get:

$$r=1/24=0.0417$$

In Fig. 5, is shown the variation of the force acting on the knife when making a ⅛ in. cut.

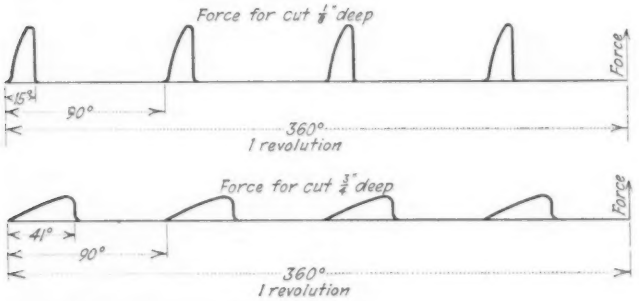


Fig. 5—Fluctuation of tangential load on a 6-in. cutterhead for a given speed, feed, and hp., and different depths of cut

While the exact shape of the curve representing this force is not known, the curve no doubt very closely approximates a distorted sine curve as shown in the figure and therefore its mean value may be represented approximately by $2/\pi$ times the maximum value. Therefore the maximum tangential force $F_{max.}$ on each knife would be:

$$F_{max}=\frac{\pi F}{2nr}$$

Applying this equation to the problem under consideration:

$$F_{max}=\frac{3.14\text{x}120}{2\text{x}4\text{x}0.0417}=1{,}130\text{ lb.}$$

For the reason set forth above it is best to assume that the entire load will be carried by one bearing, therefore the maximum bearing load will be 1,130 lb. Furthermore, to be on the safe side a factor safety of 2 should be used to allow for conditions such as bearing distortion, misalignment, temperature, vibration, and other uncertain factors. A bearing capable of sustaining a radial load of 2x1,130 or 2,260 lb., should be used.

Now let it be assumed that the board will be narrow and thick, and sufficient material will be removed so that 20 hp. will be required as before, but that the depth of cut will be increased to ¾ in. Referring to Fig. 4, the angle during which each knife is doing the cutting will be 41 deg. and the ratio r=41/360 or 0.114.

Since the horsepower transmitted is the same, the mean tangential force is the same as calculated above, or 120 lb. The maximum force will be:

$$F_{max}=\frac{3.14\text{x}120}{2\text{x}4\text{x}0.114}=414\text{ lb.}$$

Evidently the maximum tangential load with a deep cut is considerably less than with a shallow cut when using the same horsepower. The fluctuation of the tangential load for a 6-in. cutterhead, cutting ¾ in. deep is also represented in the diagram Fig. 5. It is to be noted that the distribution of force is much more nearly uniform with a ¾-in. cut than with a ⅛-in. cut. The impact varies approximately inversely as the square root of the depth of cut.

If we consider a cutterhead similar to the one in the above example but having only two knives and transmitting the same horsepower, it is evident from the above equations that the impact load will be exactly twice as great, provided the depth of cut remains the same. As a general rule, the impact load varies inversely as the number of knives, all other conditions remaining the same.

The diameter of the cutting circle of the cutterhead also has an influence on the maximum impact and should be considered in the selection of the bearing size. Referring to Fig. 4, we see that the actual cut is completed when the knife is traveling through an angle of 41 deg. However, for a 12-in. diameter cutterhead taking a ¾-in. cut, all the cutting work is done during a travel of only 29 deg. and r would then be 29/360 or 0.0805.

Again assuming that 20 hp. is transmitted, the maximum tangential force will be:

$$F_{max}=\frac{3.14\text{x}120}{2\text{x}4\text{x}0.0805}=585\text{ lb.}$$

For the same hp., and with other conditions remaining the same, the maximum tangential force is greater with a larger cutting circle, and thereby imposes a greater load on the bearings.

Summarizing the above, for a given feed and width of board, and consuming a certain horsepower, the major factors to be considered are: (1) average depth of cut, (2) number of knives, and (3) the diameter of the cutting circle.

The above analysis applies to planers, matchers, molders and similar woodworking machines using multi-knife cutterheads.

The Evolution of Tracks for High-Speed Tractors

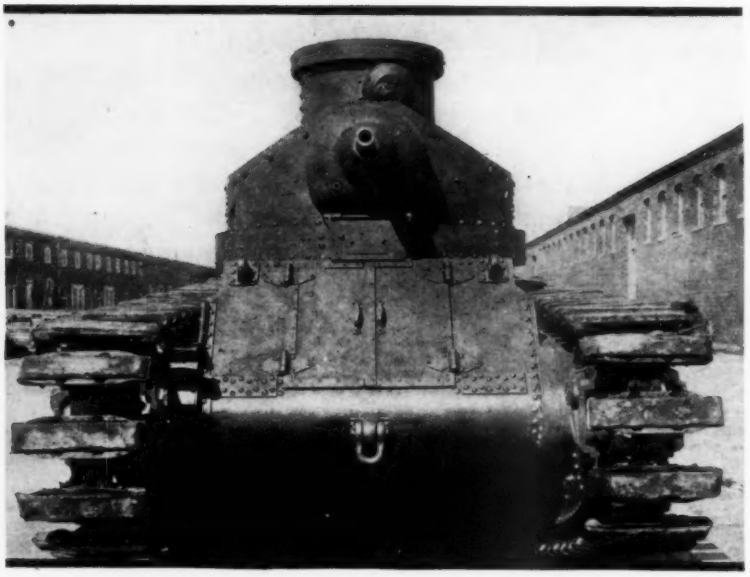


Fig. 1—The 21-ton tank of the U. S. Ordnance Department, 1922 design, used pressed steel shoes with wooden soles, as shown in Fig. 3

By C. G. METTLER
Lieut, Col., Ordnance Department, U. S. Army

Colonel Mettler has taken an active part in the development of the tracklayer tractor from a lumbering vehicle moving at four miles per hour to one more than ten times as fast. As an officer in the Ordnance Department, he has studied the problem in England and in France as well as in the United States. In this article he explains the mechanical difficulties that had to be overcome, and the successive improvements made in the design of tracks that finally made possible the present high-speed vehicle

THE FIRST vehicles employing the tracklaying principle were locomotives built for use in logging operations. They were equipped with long heavy links carrying rails on which the locomotive could progress. These locomotives worked well at speeds of one or two miles per hour, which were ample for such operations. Their success in the rough terrain of the forest led to their adaptation for work on farms and plantations. In the open meadows and prairies, greater speed could readily be used, was demanded, and in some measure was accomplished.

Then came the World War. At Cambrai, the British surprised all the belligerents by the use of large self-propelled fighting machines which were called "tanks." The success of these tanks led to a wild effort on the part of all military designers to adapt the tracklaying principle to armored battle equipment. But the tracks failed. A few hundred miles sufficed to put the tractor in the shop for track repairs or new tracks. There is little wonder that the tracks failed when we consider the stresses to which the parts were subjected.

Considering a moving tracklayer, the top track section as it moves from the rear to the front of the machine must go at twice the road speed of the vehicle. But the track on the ground is at zero velocity. As this track must be accelerated to twice the velocity of the moving vehicle as it runs around the rear sprocket, some portion of the track must be continually under acceleration from zero velocity to twice the velocity of the vehicle. The energy required is $M(2V)^2/2$, or $2MV^2$. Simultaneously, a section of the track is being decelerated from the velocity 2V to zero velocity, thereby returning most of the energy absorbed in accelerating the track. But regardless of the returned energy, the stresses in the track parts are not lessened.

As shown, the stresses caused by the changing velocity of the track element increase directly with

the mass or weight and also with the square of the velocity. But in addition, the track must also move the vehicle forward. It can be seen readily how the war tractors with increased speed soon tore their tracks to pieces. In addition to contending with the high stresses that were imposed upon the track, other problems came up.

The natural habitat of the tracklayer is not the paved highway or the smooth field, but rather the muck and dirt of the soft swamps, the road and building excavations, and the shell torn battlefields. A part of the tracklayer is always in mud, sand, or dust. The pins and bearings at the joints of the track take in grit at every revolution of the track around its sprockets. If this grit be mixed with oil, it becomes a still better abrasive than when kept dry, but in either case it wears away the metal rapidly. Therefore, if oil were to be used for the joints, it would require a perfect seal.

At high speeds the track will be thrown over the sprockets rather violently. Therefore the track must be kept fairly tight. What might be considered a normal amount of slack for ordinary chain drives, is not permissible. Therefore, the problem of minimizing the wear at the pin joints of the links is of still greater importance, yet the conditions to be contended with are such that it is extremely difficult to prevent rapid wear.

As the lower part of the track sinks in the earth, it collects stones and mud on the rails and links, which are carried up to the sprockets. These objects tend to stretch the track against its sprockets which in turn bring greater pressure against the strong spring tension devices, putting greater strain on the pins and bearings and causing serious wear at the joints. If the lower part of the track were straight, some of this earth might be shut out, but unfortunately the track must not lift the tractor over every small irregularity of the terrain. Each of the bogie wheels must be sprung to allow the track to lift.

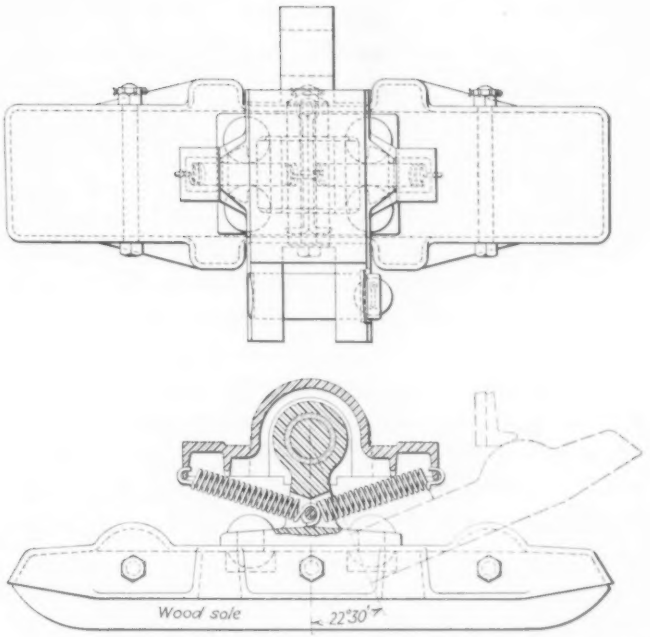


Fig. 3—To keep the load distributed across the shoe, the latter was pivoted to the link and equalizing springs held the shoe in its normal position

Another source of stress on the track pins and bearings is brought about by the method of turning. The usual method for steering tracklayers requires one track to be reduced in speed with reference to the other. In most tracklayers, one track is disconnected completely from its power by a clutch and held against movement by a brake. The other track with full engine power drives its side of the tractor, causing the tractor to turn about the dead track. The latter is thus slid over the terrain, cutting sidewise all obstacles on the ground. To calculate the resultant possible stresses on the pins and bearings requires a complicated brand of mathematics.

The story of the evolution of the modern track begins with the tracklaying locomotive already

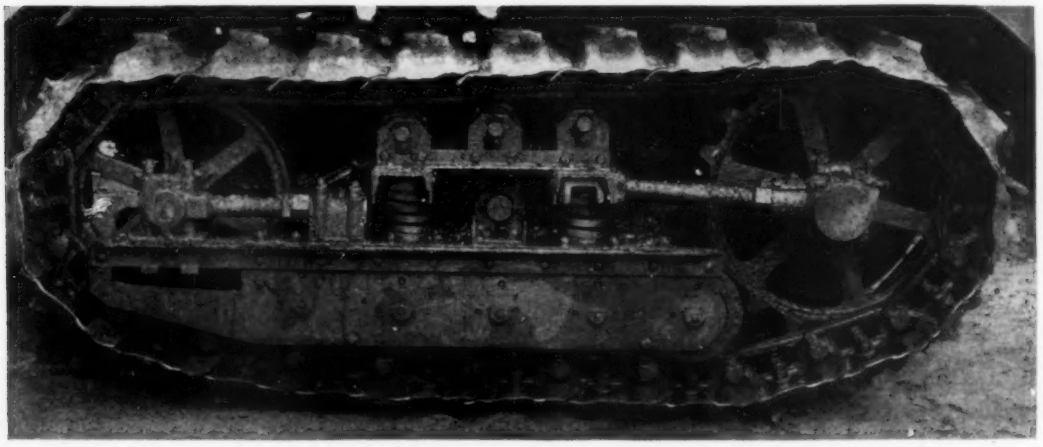


Fig. 2 — Agricultural tractors adapted for war use in 1918 had tracks consisting of shoes attached to the links. Neither the connecting pins nor pin holes were hardened. The holes elongated rapidly from wear, causing the lengthening chain to climb the sprockets. With vehicle speeds of only 4½ mi. per hr., these tracks last only 600 miles

mentioned. The links of this tracklayer were about 18 in. long and sections of track were bolted to the links. At the low speed involved, the greatest stress was that caused when the long link rolled onto the sprocket. When the individual link rolls over the relatively small diameter wheel, and is subjected to the full pulling power on the track, a large bending moment is set up at the midsection of the link. Evidently, short links are desirable in order that this bending moment may be minimized. On the other hand, the shorter the pitch of the chain the greater will be the number of link joints involved, which is undesirable because the total stretch of the chain on account of wear will be the product of the wear at each joint and the number of joints.

The first tractors naturally followed in principle the design used for the tracklaying locomotives. As shown in Fig. 2, these tracks consisted of a track link to which was fastened a track shoe. Although these first vehicles traveled only about four mi. per hr., the defects in the track design were evident. Though shorter than those used on locomotives, the links were subjected to heavy bending moments when rolling onto the sprocket. Furthermore, the principle of a track shoe attached to a link resulted in a track considerably thicker than desired because it raised the center of gravity of the vehicle. This track also brought to light another factor. When traveling over rough ground strewn with tree stumps and stones, one edge of the track would climb over a sharp elevation, leaving the other side of the track unsupported. This would cause the links to break and indicated that the track would have to be either capable of resisting the great loads imposed upon it by that condition, or that the design of the track would have to be otherwise modified. It was thought that if the shoes were made with an equalizing action it might be possible to keep the load on the shoes distributed under all conditions. The result of this idea was the equalizing shoe shown in Fig. 3.

In the developing of the track with the equalizing shoe, several other improvements were attempted. The steel track shoe was faced with wood bolted to it. The shoe was supported on a longitudinal axis at its center and heavy springs at each side held the shoe in the correct plane when not in contact with the ground. To minimize the bending moment on the links, the pitch of the chain was decreased to 10 in. The track shoes were 5 in. wide and a 5-in. gap was left between adjacent shoes.

In actual operation, however, this design of track did not work out satisfactorily. The combination of links, steel plates, and wooden soles made a chain even thicker than that formerly used, and thereby correspondingly increased the height of the center of gravity of the vehicle. When traveling in a straight line, the shoes functioned as expected, in that the load was not concentrated at one portion of the shoe. However, when the turning movement was attempted, the shoes were torn off.

Numerous other modified designs of link and shoe were tried out with varying success. Finally, about 1926, there was developed the basic design which is still in general use and has not been improved upon, in so far as this type of shoe is concerned. Separate construction of track shoe and link was discarded, the track shoe and links being a single unit, as shown in Fig. 5. The shape of the links served to minimize the slippage of the track on the ground in straight line travel, yet offered minimum resistance when the track was skidded across the ground in a turning maneuver. Having a pitch of only 4½ in., the link was subjected to a

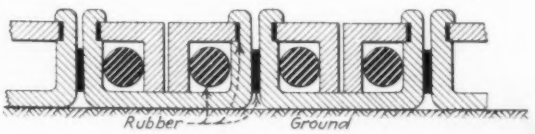


Fig. 4—There was no metal to metal bearing in the British rubber jointed tracks. Their best features were practically no elongation from wear and smooth riding of the bogie wheels. But the tracks were big and heavy

minimum bending moment when passing over the bogie wheels and the driving sprockets. Another considerable advantage of this type of construction was that, the links being thinner, the center of gravity of the vehicle was lowered. With this unit construction, the track was considerably lightened, which proportionally decreased the track stresses resulting from the acceleration already mentioned. Finally, in order to make further improvement in this same direction, duralumin links, with hardened steel bushings in the pin holes and hardened steel pins, were adopted.

Hand in hand with the developments described above, continual changes were being made in the design of the joints between the links. At first, the link pins were soft, as were the holes in the links. No lubrication was used. The holes elongated rapidly, resulting in a stretching of the chain. As an improvement, the pins were hardened. This put all of the wear on the holes. Naturally, the next step was to use a hardened steel pin passing through a hardened steel bushing

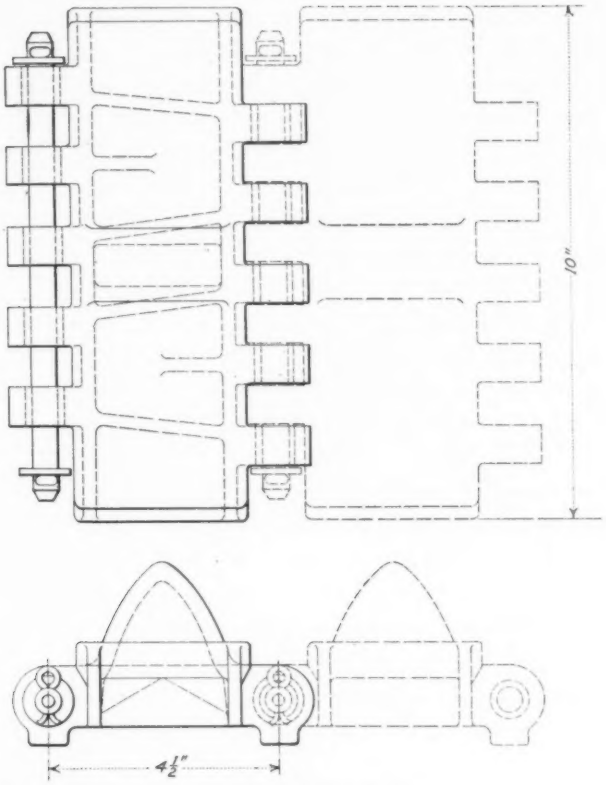


Fig. 5—Short pitch light-weight track for high speeds, designed in 1930, made of duralumin with hardened steel pins and bushings

in the link. The result of these two improvements was that the life of a track for a vehicle speed of 4½ mi. per hr. was increased from 600 to 1,000 miles.

Not only was it greatly desired to extend the life of the track, but the use of shorter pitch links made the problem of pin wear still more important on account of the greater number of joints. Improvements were attempted in many directions. Pin diameters were made larger in order to obtain greater bearing surface. This proved unsatisfactory because it required more metal in the links at the pin holes. Lubrication was attempted. In spite of the many ingenious devices used to prevent dust and dirt from getting into the bearings, it was found utterly impossible to keep out the grit. The lubricated pins wore more rapidly than those that were not lubricated.

Anti-friction bearings were tried out. The bearing housings were of necessity large and required a correspondingly larger link. Keeping out the grit was found to be practically impossible unless a very heavy and expensive construction was resorted to. It was finally concluded that considering these factors and the matter of cost, it would not be feasible to use anti-friction bearings.

In the meantime, the British were experimenting with rubber jointed tracks, shown diagrammatically in Fig. 4. In principle, this track in some respects reverted to the link and shoe type. However, in this British design, the shoe also functioned as a link, while the connecting element acted as the track on which the bogie wheels rolled. The inner and outer links were keyed together, and rubber was used to separate each of the elements. Probably the greatest advantage of this construction resulted from the overlapping of the parts that composed the track. Thus the inner members on which the bogie wheels rolled were supported at the center of the shoe links. As the bogie wheel rolled from one link to the next, the adjacent links would maintain the same elevation at their abutting ends. In other words, adjacent ends of the successive track links on which the bogie wheels rolled were always at the same elevation because they were both supported at the center of the same shoe. This eliminated the hard bumps received by the bogie wheels.

Experiments now being made point to the adoption of rubber bushings in place of pin joints. This is an adaptation of the rubber-bushed automobile spring shackle. A soft rubber bushing is pressed into a corrugated hole in the links, so that the bushing will not be able to rotate. The pin is also corrugated and driven into the bushing. The only rotation between adjacent links is that obtained through the shear deformation of the rubber bushing. If it proves successful, such a construction will be ideal. There being no relative surface motion, wear will be entirely eliminated. The number of joints in the track will then become of small importance, and it will thereby be feasible to shorten the pitch of the chains as other conditions might dictate. With duralumin links of the type described above, the track will be relatively light, thereby proportionally decreasing the stresses caused by acceleration.

There can be no final solution of the track problem because there is no fixed problem. An improvement in speed offers a new technical solution of the military problem. The new tactics at once indicate new uses and new requirements for the tracklayer and the truck. So there is a constant and healthy expression of dissatisfaction, which is a sign of impending improvement along the line. As the speed of the vehicle is increased, the life of the track is shortened. Engineering improvements are made to increase the life of the track, but as soon as this has been attained a further increase of vehicle speed is made. The present design of tracks has finally made possible vehicle speeds of 45 mi. per hr. and a track life of 600 miles maximum.

EDITORIALS

KENNETH H. CONDIT
Editor

Volume 3, Number 1

WITH this number *Product Engineering* begins its third volume. Founded two years ago by the McGraw-Hill Publishing Company to serve the product development engineer it continues with the same name and the following staff: Kenneth H. Condit, editor; George S. Brady, managing editor; Fred H. Colvin, consulting editor; and George F. Nordenholt, Frank J. Oliver, Jr., H. R. LeGrand, E. J. Tangerman, and C. G. Smith.

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Salary Scales and Recognition

Both the salary scale of designing engineers and the difficulty of procuring good men for such positions were stressed at the Annual Meeting of the American Society of Mechanical Engineers. Professor Smith of Yale, who presented the committee report on the Economic Status of the Engineer, emphasized the fact that the curves show distinctly that engineers engaged in design work receive less than the combined average salary of all engineers. Even chief engineers receive much less than is paid to men holding equivalent managerial positions in other branches of engineering.

To plead that larger salaries be paid for the creative work of engineers is useless. Business is not built on sentiment. The economic status of the product engineer can be improved only by changing his status in the organization. The engineer in sales work is constantly making new contacts. He becomes known, and thereby establishes a market for his services. His sales record, which cannot be hidden, becomes his stock in trade. As his sales rise, so does his salary.

Even in the production branch the engineer is more likely to receive recognition than in the design field. Economical manufacturing costs are reflected directly in selling price, and although the low production cost may be largely the result of ingenious design, the credit is generally given to the production department.

If more high grade men are to be attracted to designing careers, and if salaries of product engineers are to be improved, it can only be done by the individuals in that branch of engineering having their place "in the sun." And the product engineers themselves can do much to bring this about. Let the individual engineer who has engineering questions to take up with manufacturers of standard parts and equipment insist that his correspondence and conferences be with the chief engineer of the manufacturer, or a representative of the engineering department. This would be at least one step toward the proper recognition of the product engineer.

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Engineering Will Rise to the Occasion

What is going to be expected from the engineering department in the year that lies ahead of us?

The answer depends largely on what business does. One school of economic thought insists that further deflation is essential before normal activity can be resumed. The other school maintains that controlled inflation is desirable. Inflation may ease the burden somewhat, but in any case it is clear that a demand will be made for lower production costs, and that the engineering department will surely be called upon to design the product for that end.

The buyer of consumer products or industrial products is just as much interested in quality as ever, but his pocket book is not going to stand very much strain in 1932. Consequently, the consumer product that will sell will be made at a price which the buyer can pay, and will have sufficient quality and attractiveness to arouse his acquisitive instincts. The industrial product must be capable of accomplishing even more drastic cuts in manufacturing or operating costs to make it appeal to industrial buyers whose equipment budgets are going to be closely watched.

Engineering and design will thus have a heavy responsibility but at the same time an unparalleled opportunity to show ability to rise to an occasion.

What you can Do with Color

How do various colors affect users and buyers of machines and metal products? Which colors get attention? Which give solidity to the product, or restfulness, or coolness? How can color be employed to stimulate activity on the part of a factory machine operator?

Because so few engineers have had the time or the opportunity to study this phase of product development we give here five statements by experts in the use of color, telling what can be done with color. In subsequent issues we shall publish articles explaining how these effects can be secured in actual practice

Color for Attention

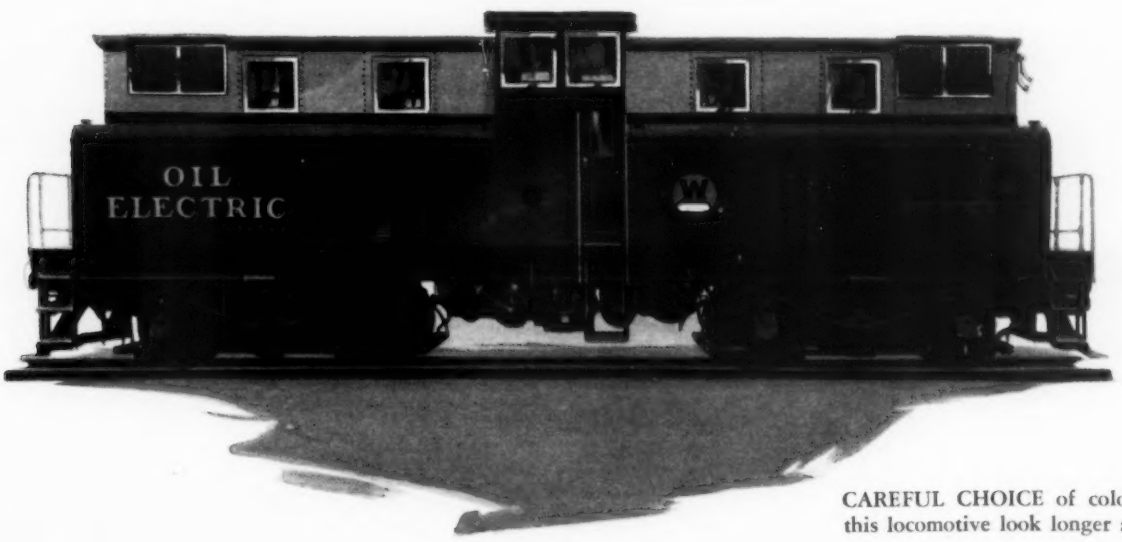
By D. R. DOHNER

Art Director, Engineering Department Westinghouse Electric & Mfg. Co.

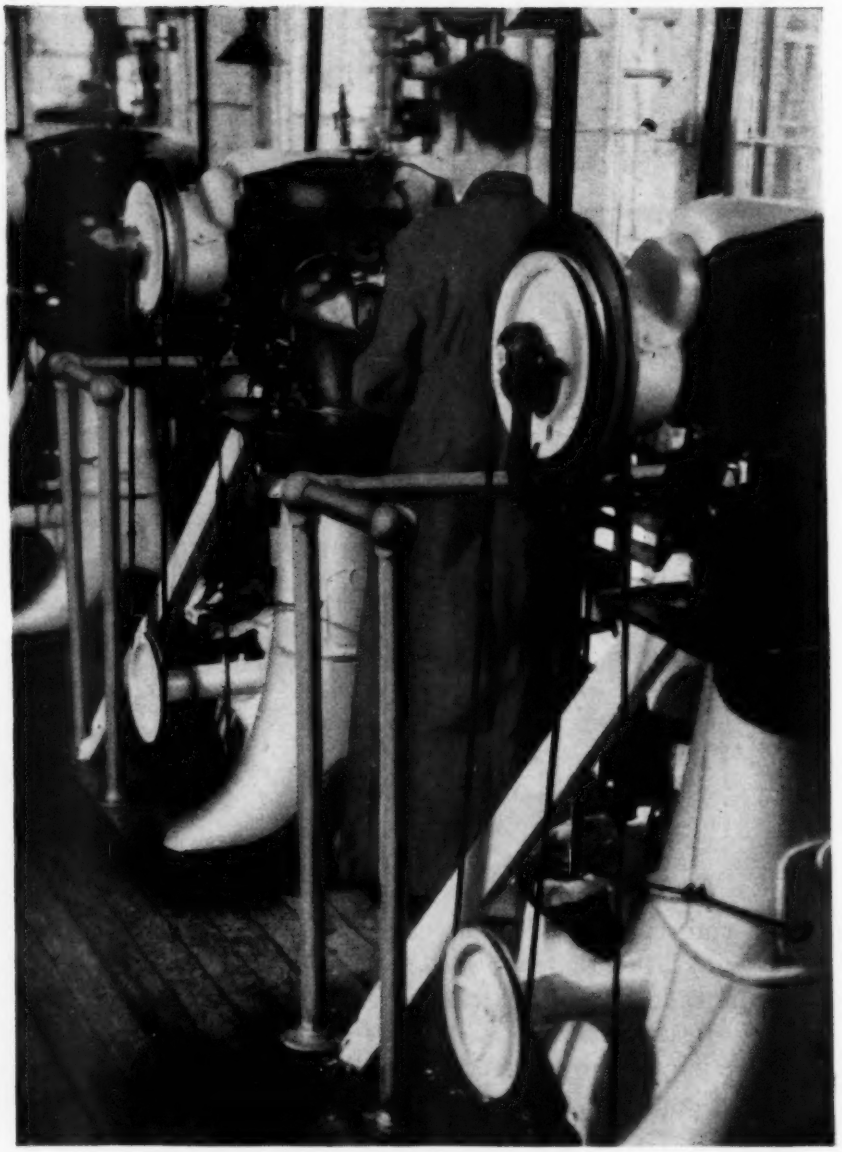
HOW can we use the power that lies in color to best advantage? At times it spurs to action, it excites, it intoxicates. At other times, it soothes and relaxes. When used with knowledge and discrimination these subtle qualities are worth money in trade. While blatant color may scream out and attract attention, it fails to sustain interest; certainly its use if related to function is decidedly limited.

The hues are divided into two classes, warm and cool. The warm hues are strong in chroma or intensity and are aggressive and stimulating. The cool hues on the other hand are retiring and soothing. Neither can say what the other says. Since refrigerators, water coolers and fans perform a cooling function, they are shown to best advantage in cool hues. We have therefore chosen a neutral green for one model of fans. On the newer "Debonair" fan an oxidized silver finish was chosen because it is neutral enough to fit into any surrounding and cool enough to have the desired psychological effect.

On the other hand, a mercury arc rectifier is a powerful, dangerous machine. A warm hue, red, serves best here, for in this case no hue can say what red does. To achieve variety without destroying the unity, the attachments are painted a warm gray of about the same value (light and



CAREFUL CHOICE of colors makes this locomotive look longer and lower



PASTEL SHADES on these shoe machines lessened eye strain, improved quality, bettered morale

dark). The base is painted black to give solidity to the huge form.

Small appliances such as the hand vacuum sweeper, porcelain percolators, micarta dishes and trays can be either warm or cool in hue and stronger in chroma as they always fit in to surroundings more highly neutralized in color.

Another factor in the use of color in industrial products, often overlooked but of vital importance, is the fact that color is closely related to form; neither exists alone. In the mercury arc rectifier mentioned before, many attachments are applied to the main cylindrical form. To paint the body and attachments the same color would result in perfect unity of color, but the result would be dull and monotonous. The color scheme would be obvious and mediocre. To use widely separated hues or values would give us great variety, making for interest but destroying the unity. Therefore, the worm gray, closely related in hue to the main body and of practically the same value, achieved a certain amount of variety without destroying the unity. Since we see pattern largely through the property of value it is desirable to use it when wishing to subordinate intricate or badly related forms. When the forms are simple and well related they can be exploited through strong contrasts of value.

Such a strong contrast of value is used on the 110-ton oil-electric locomotive. Because this particular locomotive is high, a color scheme relating to the big horizontal divisions of form was chosen to make it look lower. To preserve the unity one hue in addition to black was used. Widely separated values of this hue provided variety and accentuated the horizontal masses, making the locomotive appear longer and therefore lower and more in relationship to the ground plane.

Color Reasoning Applied

By T. J. MALONEY
The New Jersey Zinc Company

AS MODERN lines reach simplicity, color achieves variety. In other words, decoration is not passé, but the modern application of it is color applied with the proper attention to its merits for attention, identification and psychological reaction. As such it is a powerful factor in modern design and sales. The National Cash Register Company discarded the old cast brass case with its intricate weaving of scrolls, eagles, leaves and whatnot, and substituted stampings of the simplest line and the greatest color scope—red, blue, walnut, oak, white, green and orchid. Cash registers must be either complementary to, or contrasting to, surroundings. Hence this wide range of colors in no way conflicts with the psychological color values.

The Hunter Fan Company breathed life and sales into its new line of fans by painting them in various hues and selling them in sets of six as the "Rainbow Assortment." (A laundry owner in Chicago finds fewer fans stolen from the walls since they are painted a vivid orange.) Cool colors help fans, but again surroundings—backgrounds—are important.

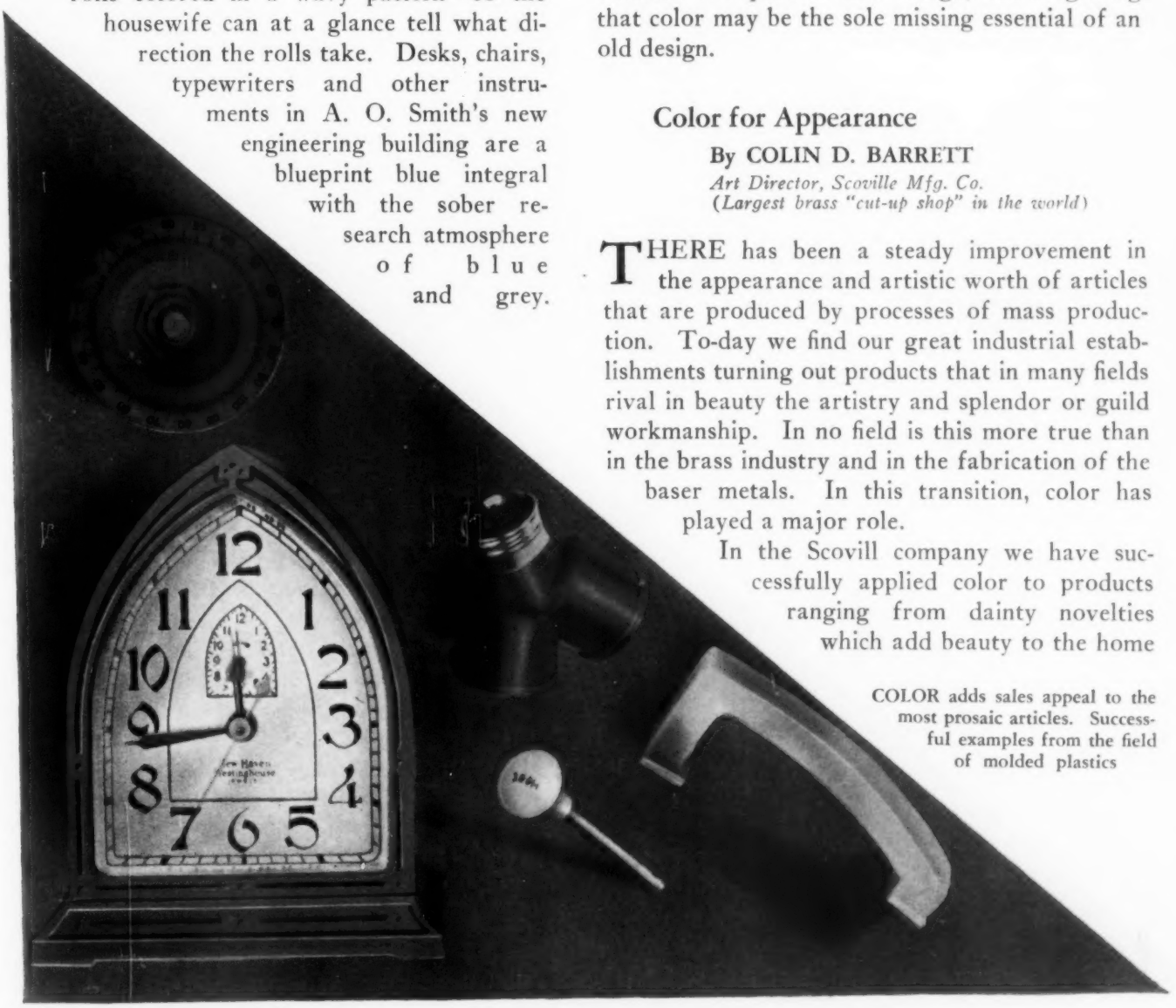
The airplane—essence of simplicity and modernity—is an advanced course in coloring. Toys—catering to the other extreme of simplicity—will not sell unless they abound in vivid hues. In both cases attention is the dominant motif.

The American Radiator Company's latest radiators are displayed in combinations of brilliant blue and apple green! Oil burning stoves and furnaces are as new in finish as in design—the pastel shades. Westinghouse makes a comprehensive study of color, and then blends it into new uses for a new plastic, Micarta.

A washing machine is marketed with wringer rolls colored in a wavy pattern—so the housewife can at a glance tell what direction the rolls take. Desks, chairs, typewriters and other instruments in A. O. Smith's new engineering building are a blueprint blue integral with the sober research atmosphere of blue and grey. Toledo Sales found more people interested in the joys and sorrows of weighing, when weighing on the colorful balance.

An ultra violet sun lamp, giving an outdoor effect to drying laundry, is colored in cool blue. Laundries, hot places, need cool colors. And though gasoline has to be good to be sold, the blue and yellow color scheme of all equipment (pumps, signs and stations) of one large Eastern producer has played a major part in the sales success. Here is the combination of identification and attention. Shoe machinery, painted the pastel shades, means less eye strain, better shoes and more contented workmen.

Examples could be quoted interminably. The World's Fair in all its aspects, machinery, buildings, interiors, exteriors, is going to portray vividly and to accentuate colors that will rival the variation of the rising or setting sun. Manufacturers are making fine, fast colors. Color is so definite a sales asset every product engineer should consider it a part of new design, not forgetting that color may be the sole missing essential of an old design.



COLOR adds sales appeal to the most prosaic articles. Successful examples from the field of molded plastics

Color for Appearance

By COLIN D. BARRETT
Art Director, Scoville Mfg. Co.
(Largest brass "cut-up shop" in the world)

THERE has been a steady improvement in the appearance and artistic worth of articles that are produced by processes of mass production. To-day we find our great industrial establishments turning out products that in many fields rival in beauty the artistry and splendor or guild workmanship. In no field is this more true than in the brass industry and in the fabrication of the baser metals. In this transition, color has played a major role.

In the Scovill company we have successfully applied color to products ranging from dainty novelties which add beauty to the home

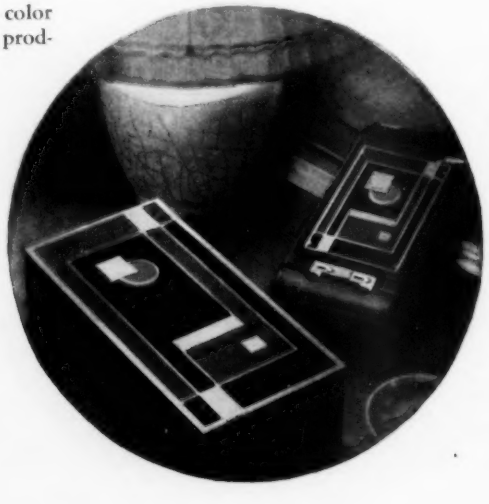
to highly technical machines that by their appearance as well as mechanical efficiency are assets to a factory's equipment.

Our reasons for using color on our products are twofold. In the first place, there is the natural pride we take in turning out a product that by its external appearance as well as its utilitarian worth shows itself to be a thoroughbred in its field be it an ash-tray, a hub-cap for an automobile, or a piece of factory equipment. In the second place, we have found by experience that beautifying our products by the use of color adds substantially to their sales appeal.

This increased value of an attractive product over an unattractive one is exemplified in the automobile hub-cap field where the application of color elevates it from the status of a minor mechanical accessory and makes it a definite addition to the beauty of the complete motor-car. Again, color applied to the humble drink-mixer which is present at all soda fountains makes it an attractive addition to the counter and one that aids in creating an impression of efficiency and cleanliness rather than an obscure piece of equipment to be kept in the background. Even in the field of purely mechanical products typified by a button machine, the application of color not only adds to the sales appeal by exemplifying the quality nature of the product but makes the machine more truly a part of a modern factory interior.

That the artistry of any object is not dependent entirely on color but also arises from its line and contour is obvious, but it is color applied by all the methods of printing, inlaying, etching, lacquering, japanning, and enameling which we use, that we find to be one of our chief aids in making our products, manufactured by mass methods, partake of the quality and aesthetic attributes generally ascribed to the craftsmanship of the small workshop of a bygone day.

PATTERN and color synchronized on product and package



The Psychology of Color

By WALTER DORWIN TEAGUE

Style Consultant to Eastman Kodak Company, Bausch & Lomb Optical Company, Taylor Instrument Company, Marmon Motor Car Company; Designer of Products for Thomas A. Edison, Inc., National Radiator Corporation, International Telephone and Telegraph Company

IT IS EASY to be lyrical about color, difficult to use it practically. Color, like music, is an emotional stimulant, hence the temptation to treat it emotionally. But in using color to stimulate the other fellow's emotions, our own may only get in the way. Color, like sound, is a sensation produced by the impact of ether waves on certain specialized nerve-endings. The sensasations vary with the length of the waves. According to the mathematical relationships existing between different wave-lengths, we find their combination beautiful or distressing, soothing or exciting, gay or sad.

In a big city hundreds of unrelated sounds beat upon our ears. They merge into a roar and we cease to hear them. But if a band marches nearby we pick its sounds out of all the rest and give them our attention. These sounds have a conscious order, they make a pattern. So they have meaning for us and we listen. Similarly, we see color of a kind all the time that we see anything at all. In order to fix our attention and stimulate us pleasurably, color, like sound, must have a definite arrangement; its mathematical relationships must be rightly ordered.

Another way to focus attention on a color or a sound is to make it much louder and wholly unrelated—discordant—to all around it. But the effect is a shock, and not pleasant. Better take a lesson from nature, whose color is never shocking or tiresome. Her large masses are cool and restful: blue sky, green fields and foliage, violet shadows. She saves her vivid reds and yellows for accents—flowers, fruit, birds. Or if she flings hot colors across a sunset sky or an autumn landscape, the performance does not last long enough to oppress us. Thus you would tire of a vermillion piano, but perhaps not of a vermillion cigarette case.

Forty thousand years ago the Cro-Magnons were painting themselves and their caves—very well, too. We are still doing both. If you make anything for us or our caves, or our workshops, it will be doubly welcome if you make it the right color. No one can tell you what the right color is until he knows what you are making and how it is to be used.

Color—a Recognized Factor in Automobile Sales

By H. LEDYARD TOWLE
General Art Director, Campbell-Ewald Company

BEFORE the introduction of the pyroxylin lacquers it was common practice to paint the more expensive makes of automobiles in special color schemes, but the makers of large production units used nothing but black and dark blue enamel. This was sound, from a cost standpoint, as long as so many "first car" owners existed, but as time passed and more people became familiar with the automobile, they demanded more frequent model changes and greater variety in the decoration and appointments of the various makes of cars. The coming of Duco and other pyroxylin lacquers made it possible to place any number of hues on "big production" cars at actually less expense than by the old process use of baked enamel.

Many experiments were made in the use of dark and light colors in order to determine whether any given model could be painted to look longer and lower.

It was discovered that the proper use of color on an automobile could be made to bring out its best (or sales) points and the manufacturers were not long in establishing departments whose sole function was the experimental use of color to bring out the greatest beauty in their products. Authentic style sources were investigated and studied. The famous Parisian dress designers, long experienced in the use of color (to make fat women look thin and thin ones look fat) were asked for their valued advice. Well-known artists forsook the painting of pictures and turned to the creation of beauty for a wider public.

All of this activity soon proved that color, rightly employed, could enhance the value of a manufactured product and make it more salable. So, "Color" arrived in the automobile industry and took its legitimate place as a sales factor.

Today constant investigations as to public color preference are carried out by all of the larger automobile manufacturers. Through their far-flung army of salesmen and executives, checks are made on the increased popularity (or vice versa) of all the basic colors. Dark blue, green, maroon, grey, the beiges and black, together with all of the lighter hues, are charted as to popularity.

It is interesting to know, for instance, that browns and beiges have been popular in California and the Southwest, that Florida likes greens, that Chicago and Detroit lean towards dark blue and that New York and some sections of the East go for black or maroon in a big way.

The cars of today are very beautiful but the cars of tomorrow will be more fitting and lovely in color and design because of the forward thinking of the men who engineer them.

The Aesthetic Appeal in Color

By NAN HORNBECK

HOW many times have you heard an engineer remark: "Oh yes, people buy the colors they like, but they can't tell you why they like them —outside of the possibility that color has something to do with making a car look elegant, powerful or speedy." And he is just learning that this is exactly what color will do for a product if rightly used. This is the element of emotional response which we recognize in music and other forms of expression, but have so far ignored in color. We have gone in for psychoanalysis, character development and expressionism in a big way, but should not the modern manufacturer invest his product with character as well as beauty by applying psychology to its color styling, basing his conclusions on the purpose, size, design, ultimate surroundings and market of his product?

To the manufacturer who asks: "Why use Color at all?" we answer: "To stir an emotional response in the prospective buyer (or consumer); perhaps to induce a feeling of relaxation and luxury, as violet and orchid may be counted on to do; or to move the user of a machine to wholesome activity, which certain greens inspire; to create a desire for meditation, if blue of the proper value is employed. To repress the emotions, to humble and efface the object, we use gray; or to rouse the senses and give an impression of heat and power, scarlet never fails. And there are as many more sensations as there are colors blended from these.

Unless, therefore, the engineer seeks to harness the elusive rainbow, and make positive use of color in this way, we shall merely go on adding nondescripts to an already flooded market, defeating whatever merits of design, workmanship and performance the product may possess, and resulting in a "character" which is altogether negative in "eye appeal," and therefore in sales value.

Doesn't it follow then that when the right colors are applied to products they must evoke those particular emotions in the buyer so ardently desired by the manufacturer and dealer, which they regard as a mysterious, an undefinable something, and which is an attribute to "sales appeal"?

Where are we Going with the New Materials?

Depression was not apparent in materials research in 1931—"Stainless" steels have developed to such an extent that the name has become a byword to the man in the street—Light alloys will revolutionize transport equipment—Cast iron has been rejuvenated—More standardization of alloys is needed and better classification

By GEORGE S. BRADY
Managing Editor

PROBABLY the principal highlight of the year 1931 in the advance in materials of engineering is the extended application of "stainless" steels, although in their respective fields of use the plastic molding materials and the high-strength irons have been outstanding. Die casting possibilities have been increased by the advances in higher strength zinc-base alloys, by success in brass castings, and by researches on magnesium-base castings. In the steel-casting industry there has been an extended use of alloy castings because of the bettered quality obtained from close control, and there has been more interest in the use of cast carbon steels for very large castings because of improvements in design technique that have given stronger castings with less material.

Broadening Field for "Stainless" Steels

Improvement in workability of the high-chromium steels is the principal factor that has operated toward the more extended use of these materials, and this has made them readily adaptable to applications for drawn and formed parts for food-handling machinery and chemical equipment. It was only three years ago that the Carpenter Steel Company demonstrated the "impossible" at the Philadelphia A.S.S.T. Show with its free machining "stainless" screw stock. Since that time machinability has so far improved in most grades of high-chromium steels that it is no longer an insurmountable problem. Improved casting of these high-alloy steels has also made them readily available now for valves, fittings, and for machine parts where acid-, heat- and corrosion-resistance are important.

In oil-well machinery and in refinery equipment the "18-8" steels have enabled equipment to be designed to withstand higher pressures and temperatures. Until recently cast and wrought iron and carbon steels were the chief metals employed, and the severe loss of metal thickness because of rapid corrosion at high temperatures and pressures hampered development of equipment to meet advances in technique of refining. Parts in cracking stills that were exposed to the action of the sulphur in crude oil, which gave a life of only 2,000 hours with carbon steel, have shown 10,000 hours of service with no measurable loss when made of the new 18-8 steels. Pump rods and valves made of high-chromium, high-nickel steels are also being used in oil and chemical machinery. A steel brought out during the year to resist creep and corrosion at high pressures and temperature is "Cro-Tung." It has the physical properties of the 18-8 group and will remain stable at temperatures up to 1,500 deg. F. A rather complete line of corrosion-resistant steel for varying uses also came on the market under the name of "Bethadur." On the other hand the alloy steels have not been found to be cure-alls, and in some cases where they have been used for parts in food machinery exposed to vegetable acids they have not given good service and have had to be replaced with pure nickel.

At the A.S.S.T. Show in Boston there was exhibited a composite metal, Su-Veneer, in which a stainless steel was veneered and weld-bonded to a mild steel base. Another metal of this type put

out during the year is "Plykrome." Composite metals are not entirely new, since nickel-clad and aluminum-clad metals have been used for corrosion resistance for some time, but the advantages of a chromium-clad soft steel is obvious where high workability is required and where a chromium electroplate would not give adequate protection. A newly offered composite sheet metal, "Chromaloid," has chromium bonded to zinc or any other base metal. Besides workability the composite metals have the advantage of lower cost than the straight high-alloy metals. In general, there is a tendency toward more ingenious use of the chromium alloys, and a probability that the conquering of the age-old bugaboo of corrosion will have an effect throughout the field of machinery.

Progress in Light Alloys

The light alloys have progressed steadily during the past year due largely to the search for new outlets for magnesium and the continuous research on aluminum going on in the Aluminum Research Laboratories. During 1930 the price of magnesium dropped from around a dollar a pound to about 50 cents a pound. During the year 1931 the Dow Chemical Company announced a reduction to 30 cents per pound. The use of this metal for automotive pistons has been well known, but lately it has been adopted for reciprocating parts for all kinds of machinery where the factor of inertia must be considered. Three companies are now experimenting with magnesium-base die castings, and success with these will undoubtedly forecast the use of magnesium alloys for a wide variety of parts. The Dow company, the largest producer of the raw metal, has started off on the right foot with a carefully arranged series of standard alloys. The cast alloys give strengths up to 28,000 lb. per sq.in., but much higher strengths are possible in the forged alloys, and will probably be attained in the die-cast alloys.

It has been claimed by some that with the preponderance of magnesium and aluminum in the world these two metals will become the outstanding construction metals of the near future. Some of the important automotive builders succeeded in making tremendous weight savings in their buses and trucks during the past year, and it is to be expected that out of the present difficulties of the railroads a complete revamping of equipment to incorporate light metals will come. Savings of 50,000 lb. per car are easily visualized with consequent economies in dead-weight haulage per passenger, lighter engines, fuel savings, and less track wear. This is a field where economic and political factors have not yet permitted the design engineer to function freely.

New Aluminum Alloy Applications

In regard to progress with the metal aluminum, Junius D. Edwards, assistant director of research at the Aluminum Research Laboratories, has summed up the year's achievements thus:

"Aluminum alloy shapes are now being used to save weight and improve performance on bridge-type cranes. These can be accelerated and decelerated faster if made of aluminum. Crane booms for drag-line buckets can be longer if made of aluminum, while the bucket itself is lighter and larger when aluminum is used in its construction. Aluminum is finding new uses in the transportation field—in the construction of truck chassis, railway cars, both passenger and freight, bus and truck bodies of all types, and electric locomotives.

"During 1931 progress was made in developing new aluminum alloys for specific purposes. Aluminum Company of America's new 4S alloy has properties intermediate to the well-known 3S alloy and the heat-treated strong alloys. The 4S alloy is not heat-treatable but its properties, like those of other common alloys, depend upon the degree of cold work it has received. It is resistant to corrosion, can be formed readily, and with a fatigue limit of about 14,000 lb. per sq.in. in the annealed temper, it appears promising for use where the metal is subjected to vibration."

Die Casting in Zinc and Brass

During the year 1931 there was released a new zinc alloy, Zamak No. 3, which is claimed to mark one of the most fundamental advances of recent years in the die-casting industry. Its sponsor, the New Jersey Zinc Company, states that it is the first alloy developed which assures the permanence of physical properties and freedom from dimensional changes during the life of a die casting. Although some of the original physical properties have slightly lower values than other zinc die-casting alloys, they are still well within commercial limts and the impact strength is greater, which is the most important property in the majority of all die castings. Many accelerated tests run in the research laboratories of the company have indicated the retention of these values over periods of at least twenty years.

Another promising development in die casting was offered by the Doehler Die Casting Company in its brass die castings. A wide variety of these show excellent physical qualities, sharply cut lines, and shapes not possible in forgings.

Iron Takes a New Lease of Life

Cast iron, one of the oldest of construction metals, has taken a new lease of life. When the late Richard Moldenke a few years ago prophesied iron with a tensile strength of 100,000 lb. per sq.in. and based his conclusions on a theoretically perfect structure he was not given a great amount of credence. At the present time there have been placed on the market a great number of irons ranging in trade names through the whole alphabet from Adamite to Z-metal, and these are variously classed as alloy cast irons, high-test irons, and heat-treated irons, but are all offshoots of the old foundry iron. High-test cast irons lately developed easily yield strengths above 60,000 lb. per sq.in. in tension without any metallic alloying elements, and one heat-treated iron placed on the market this last year is claimed to give 110,000 lb. per sq.in. With alloying elements, including silicon, nickel, chromium, and molybdenum, it has been found possible to attain almost any desired property in cast iron for machine parts, such as glass-hardness in rolls, high corrosion resistance for pump parts, and toughness for transmission chain links. Uniformity in structure, due to better processing, has also taken cast iron out of the class of undependability.

What is said of iron castings is also true of steel castings, and the improvements in these old metals have now reached such a stage that all of the old statements and calculation formulas standardized in textbooks for many years are now practically valueless. The development of these metals has also reached a point where the designer must be handed some definite standard classifications in order to permit him to proceed intelligently with their application.

Chemistry Gives Us a New Plastic

The synthetic molding materials have had a phenominal rise within a very short period of time. New compounds from a wide range of chemicals have been introduced continuously, and their varying physical characteristics are beginning to be classified more systematically to fit them into particular uses. A new urea resin suitable for parts in light colors was developed by the Mellon Institute laboratories during the year and is being manufactured. A new styrol plastic, "Victron," is colorless, not brittle, easily machined, and not absorbent to water, making it very suitable for electrical parts. Another new thermoplastic with high dielectric strength suitable for electrical parts is "Codite." These molding materials have rapidly replaced metals for such uses as clock and instrument cases where the one molding operation has produced a part made previously by numerous machine operations. As the variety of physical characteristics become more available and are classified for use the designer is going to extend the uses to many mechanical parts, especially in the grades of plastics with paper and fabric filler where the strength is relatively high.

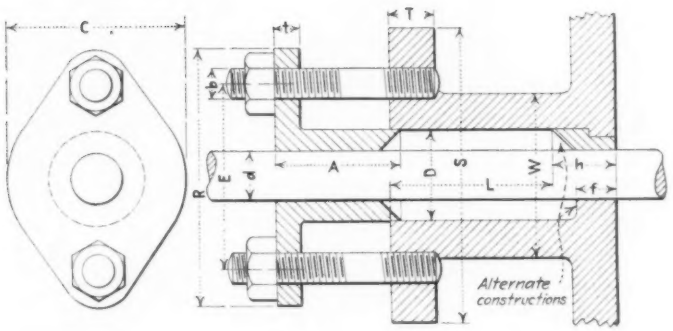
The older phenolic molding materials have progressed perceptibly during the year. General Plastics reports that the greatest demand is for black and brown, but this company is now producing its "Durez" in sixteen colors. The Bakelite laboratories were active in advocating refinements, classifying and adding new characteristics to meet wider conditions. This company alone has a range of several hundred varieties of materials, and it has specified four or five different types in one piece of apparatus, each type to meet a different set of conditions. The immediate need in this direction from the standpoint of the design engineer is classification and standardization of types and grades so that he can adapt them readily to the needs of his product.

Research Improves an Old Material

The brass and bronze industry has not been standing still. New alloys, especially ones containing nickel, aluminum and silicon, have appeared regularly. The ancient heat-treatable bronzes in which a nickel-silicide is formed have been revived and put on the market in several grades for such uses as airplane engine valve seats. Aluminum bronze, which has been in disrepute in many plants because of the danger of hard spots, has recently attracted attention because of improvements in casting technique. One company, recently marketing permanent molded castings in this metal, claims positive control and uniformity of the metal structure. It was pointed out in engineering papers during the year that control of the alloy structure is as important as proper alloying in bronze casting, especially for such parts as bearings. Leaded bronzes have recently been made more practical for bearing metals by the incorporation of small amounts of other elements to hold the lead in solution. Like the newer industry of plastics, the older industry of brass and bronze is suffering from lack of classification and standardization. One of the most important present needs of the entire construction materials field is to get it on a plane where the information on the vast number of materials in their almost endless varieties and types will be made more readily comprehensible to the specifying engineer.

Typical Designs of Stuffing Boxes

Formulas for proportioning cast-iron stuffing boxes with brass glands are given, as well as the fundamental equations for calculating the principal dimension when other materials are used or higher pressures are involved



Bolted Flange-type Stuffing Box

The design hinges upon the size and number of rings of packing to be used. An average of values given by empirical formulas for the inside diameter of the box is:

$D = 1\frac{1}{4}\ d + \frac{1}{4}$ in.

For ring or spiral packing, this figure must be modified to conform to standard packing sizes which range from $\frac{1}{4}$ in. upward in steps of $\frac{1}{16}$ in. The number of rings or turns of packing to be used is a matter of engineering judgment, and will determine the length of the box. Six rings are an average for steam engines. On this basis, other proportions may be taken as follows:

$h = 1\frac{1}{4}$ to $2\ d$

$f = D - d$, (an alternate construction if the back bush or neck brass is not to be used).

$L = N\ (D - d)$

N = the number of rings to be used, usually ranging from 5 to 7

$A = \frac{3}{4}\ L$

$W = 1\frac{1}{2}\ d + \frac{1}{2}$ in.

$b = \frac{1}{4}\ d + \frac{1}{4}$ (for 2 studs)

$E = W + 2\ b + \frac{1}{4}$ in.

$R = E + 2\ b + \frac{1}{4}$ in.

$t = 1\frac{1}{2}$ to $2\ b$

$C = W + \frac{1}{4}$ in.

$S = E + 2\ b + \frac{1}{2}$ in.

Stuffing box glands are usually brass, while the box, which is often an integral part of the cylinder, is cast iron. The above formulas are based on these materials and cylinder pressures up to about 200 lb. per sq.in.

Stuffing boxes using other materials, and for higher pressures, can be designed as follows:

1. The wall thickness, w, of the box should be calculated from the cylinder formula:

$$wf = \frac{Dp}{2}$$

p = cylinder pressure in lb. per sq.in.
f = allowable working stress in lb. per sq. in.

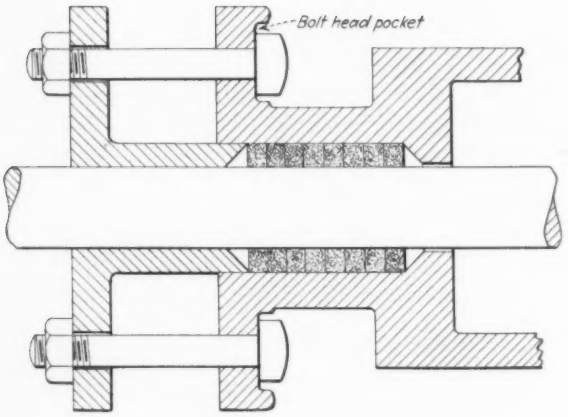
2. The number of studs or bolts, n, is two for rods up to about 4-in. diam. For larger rods, 3 or more bolts are used. The bolts must be strong enough to hold the gland against the internal pressure, which load P will be:

$$P = \frac{\pi\ (D^2 - d^2)\ p}{4}$$

Assume that for two bolts, one bolt must be able to carry the full load.

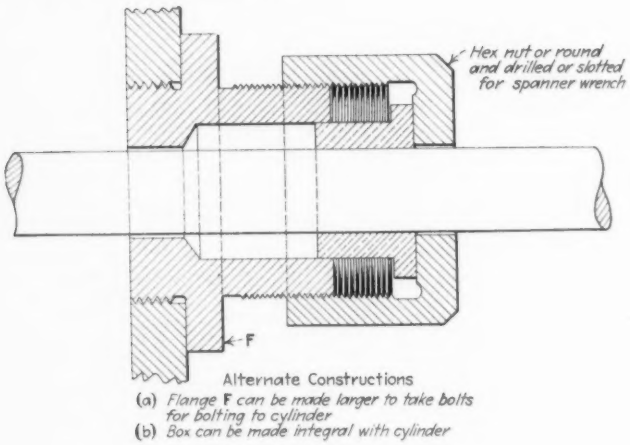
The flange of the gland must be thick enough to resist the maximum load that the bolt can put on it. It is calculated as a cantilever beam whose length is equal to the distance from the outside diameter of the gland to the centerline of the bolt.

Through bolts can be used in place of studs. A slot instead of a bolt hole is put in the box flange. Pockets are provided for the bolt head to prevent turning. This construction is particularly suitable for small cylinders and may be



found more economical because it eliminates tapping the cylinder and driving the studs.

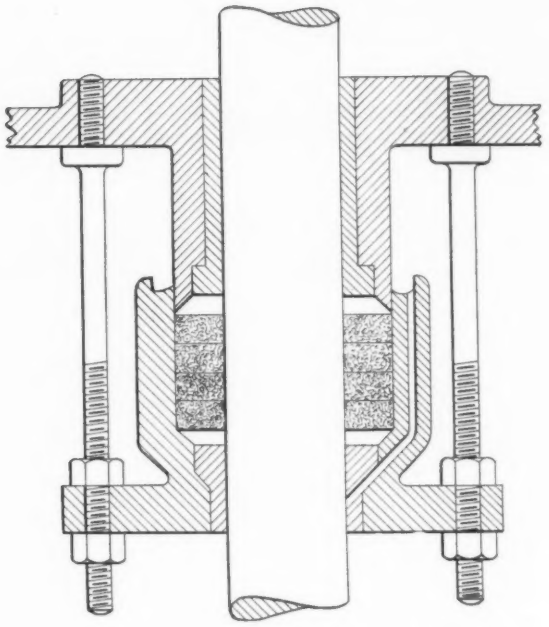
Screw-type Stuffing Box


Hex nut or round and drilled or slotted for spanner wrench
F
Alternate Constructions
(a) Flange F can be made larger to take bolts for bolting to cylinder
(b) Box can be made integral with cylinder

The proportions can be made the same as the corresponding dimensions of the bolted flange type. This box can be made to screw into the cylinder, as shown, so that it can be replaced readily. The follower nut may be hexagon for a wrench fit, or round with holes or slots for a spanner wrench. Screw-type stuffing boxes should be used only when the packing space and take-up can be made relatively short, and when the rod diameter is small. The packing space is usually limited to accommodate only about two rings, or the equivalent soft packing.

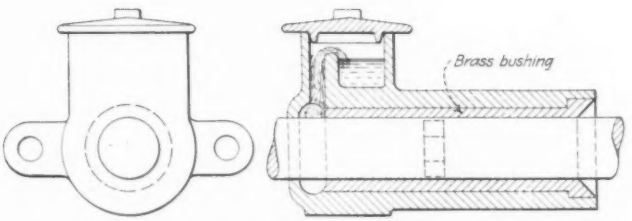
Inverted Type for Marine Engines

The lip on the gland serves as an oil reservoir for lubricating the gland. The neck bushing is made extra long to give a large bearing surface. The gland is cast-iron and bushed. Glands for any type of stuffing box can be lipped at the top when used on vertical rods, to collect the oil that



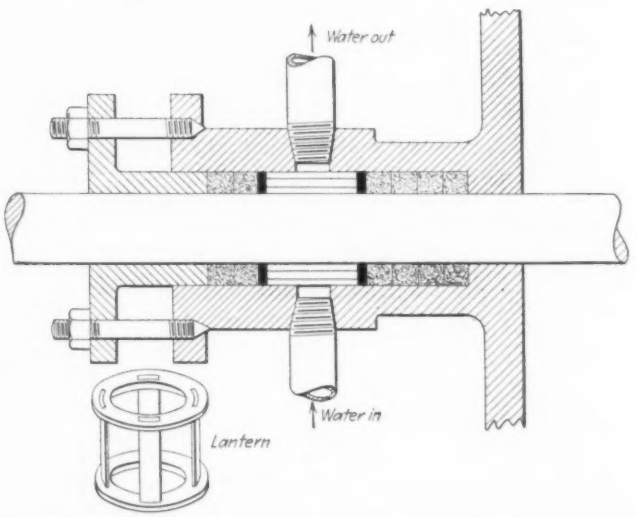
is wiped off the rod and guide it back into the gland.

Horizontal Gland with Oil Reservoir for Lubrication



The chamber is filled with waste which is also forced down into the passage and onto the rod, thus giving a wick lubrication.

Lantern-type Water Seal



A continuous flow of water through the stuffing box prevents air leakage.

Bending Moment, Shear and Reactions of a Beam Bearing a Concentrated Load

REFERENCE BOOK SHEET

ON THE next page is shown a quick and accurate method for finding the bending moment, shear and reactions of a beam or shaft with a concentrated load at any position between bearings or reactions. To obtain the correct mathematical answer it is only necessary to connect several known variables with a straight-edge. A similar chart for other conditions of loading has been published (*PE*—June, 1931, page 287) and may be used with this one for solving combination loadings.

This five-line chart consists of six scales. The left-hand scale is actually made up of two scales, *P* and *L*. The load *P*, falling any place between the reactions, is in pounds, while the *L* scale refers to the total length of the shafting or beam between the supports or reactions R_1 and *R*, and is in inch units. The next scale, labeled *a*, represents the shortest span, in inches, on the beam between load *P* and reaction R_1. Line Q_2 is for pivoting, as will be explained in the following problems. The next line consists of three scales, labeled *b,S,Q*. The longest span in inches between *P* and *R* is referred to by *b*. Scale *S* is for finding maximum shear in pounds. This is equal to *R* only when span *a* is less than span *b* as indicated. *Q*, shown at the top of these scales, is used as a turning scale only when dealing with bending moment equations. The last scale gives maximum bending moments *M* in lb.-in. units.

When solving for bending moments and shear, it is best to solve first for *S*. While the straight-edge is still in position, solve for bending moment by placing the point of a sharp instrument on *Q* (same scale line as *b* and *S*), move the straight-edge to the known span *a*, and the bending moment will be indicated. The keys at the bottom verify this statement; that is, the shear key conveys that the following two pairs (*L* to *S* and *P* to *b*) should always be connected by straight lines intersecting at Q_2. Also the bending moment key has the same connecting letters, except that *Q* replaces *S* and is used as an intersecting point for line *a-M*.

Example—A 2,000-lb. gear on a $5\frac{7}{16}$-in. diameter shaft with bearings 3 ft. apart is 10 in. from the left-hand bearing R_1. It is necessary to move this gear 5 in. to the right. Including the weight of the shaft, find the maximum bending moment, maximum shear, and bearing loads caused by the gear, before and after alterations.

With the gear in the first position, it will be found that shear *S* is equal to 1,400 lb., bending moment 14,500 lb.-in., bearing load R_1, 1,400 lb., and bearing load *R* 600 lb. Considering the uniform weight of the shaft equal to 236.85 lb. (78.95 lb. per ft. x 3 ft.) and referring to the chart previously published (*PE*—June, 1931, p. 287, Vol. 2) on scale *C*, a uniform load is shown by condition 8. The bending moment as found by this chart is 1,100 lb.-in., the shear is equal to 118.4 lb. ($W/2$= 236.85/2), and the reactions R_1 and *R* equal 118.4 lb. Therefore, as all of these results have like signs, they should be added together, giving the following figures: Maximum shear, 1,518.4 lb. The computed result is 1,562 lb. The maximum bending moment is 15,600 lb.-in.; bearing loads 1,518.4 lb. R_1 and 718.4 lb. *R*.

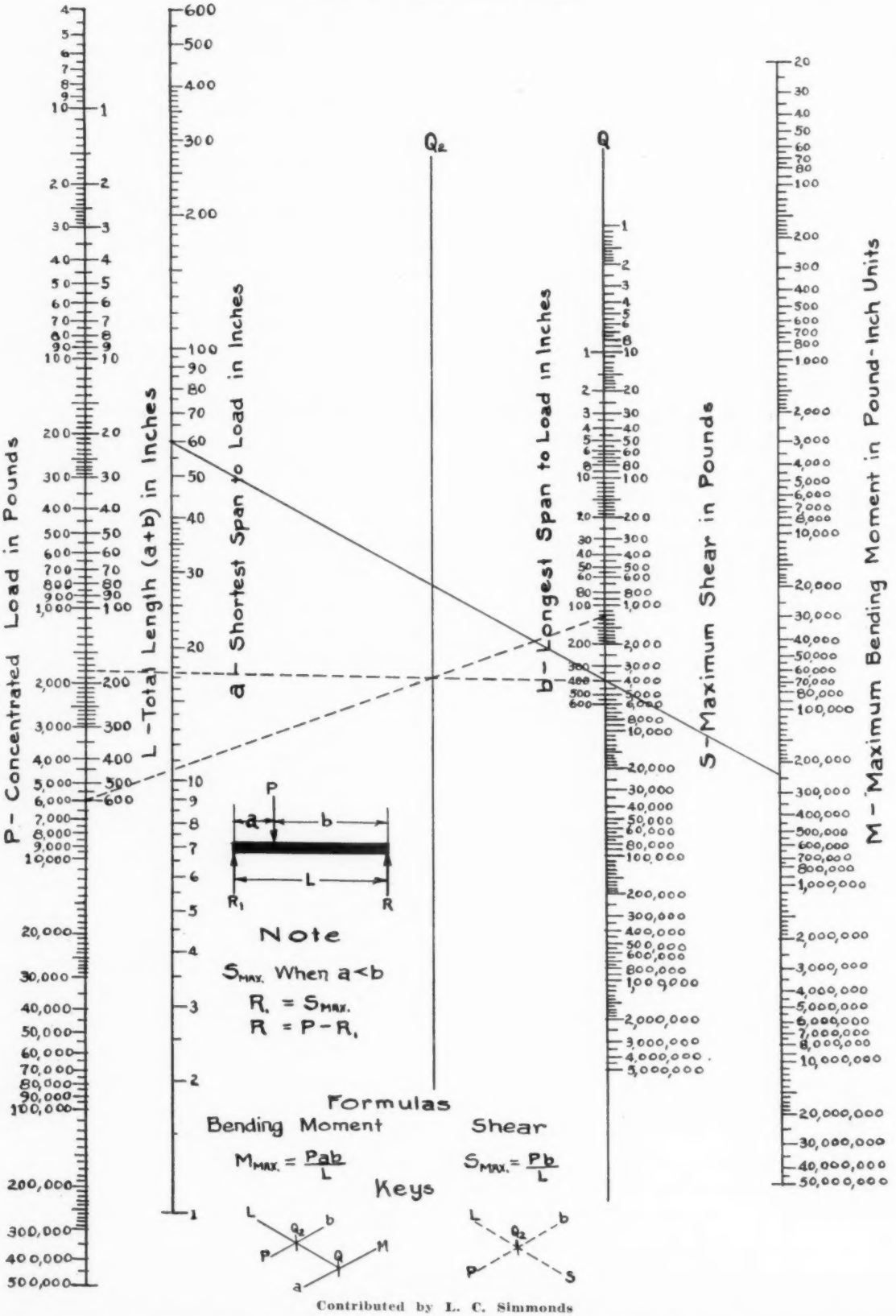
These figures take the following values when solving for the new location of the gear. Bending moment equals 17,500 lb.-in., checking with the computed result. The shear is 1,180 lb., as compared with the computed figure of 1,167 lb. To these figures, add the above shafting results, which will give the following comparative digits: Maximum bending moment is 18,600 lb.-in. Computing for this result gives 18,566 lb.-in. Maximum shear is 1,298 lb., as compared with 1,285 lb. computed. The new bearing loads are R_1 1,298 lb. and *R* 938 lb.

Generally an increase in bending moments would mean an increase in the shaft diameter, but in this case no change is necessary.

Note—The chart previously published (*PE, June 1931*) may be made more useful by adding the following shear equations to the right of the "Turning Scale," opposite each loading condition. Beginning with the first (i.e. Uniform load on beam, fixed ends) place $S_{max.} = W/2$; then opposite the next condition, and so on, place $P/2$; $5W/8$; $W/2$; $2W/3$; $W/2$; $11P/16$; $P/2$; W; $P/2$; P; $P/2$; and P, respectively. It might also be suggested that the right-hand reaction equals the maximum shear (i.e. $R = S_{max.}$ and $R_1 = W - R$ on the chart).

Bending Moment, Shear and Reactions of a Beam Bearing a Concentrated Load

REFERENCE BOOK SHEET



Contributed by L. C. Simmonds

Welding—the Engineer Can Make It or Break It

By R. KRAUS
Supervisor of Welding Inspection, Westinghouse Electric & Manufacturing Company

Preparation, amount of welding, handling and accessibility of joints—these three factors spell the difference between economy and extravagance in welded design. A welding inspector explains specifically what engineers can do about it

IT CANNOT be repeated often enough that the foundation for economical production is laid on the drawing board. Cost, a primary consideration in any production operation, is a governing factor in welding, and must receive primary consideration by the designer. He controls the proper use of structural and other elemental parts as well as the types and locations of the welds, hence it is essential that he have a knowledge of the fabrication processes and welding technique.

The result of a designer's efforts commands a price in proportion to the value of the service it performs relative to its cost; that material or labor is wasted which does not play its full part in increasing the production, quality, or life of the finished unit. Designs and workmanship should be classed as fully satisfactory only if they meet the requirements expected of them.

These statements will be clarified by a discussion of the fabrication of machine elements with three essentials in mind: the preparation prior to welding, the amount of welding, and the necessary handling and accessibility of the welded joints. Good introductory examples are welded rings, used frequently for component parts of almost every type of machine. Ten different designs of welded rings will here be shown, each suitable to meet the requirements of its respective application at the lowest possible production cost. A ring that can be classed as 100 per cent from a welding standpoint is shown in Fig. 1. It requires careful preparation: The ends must meet within close limits to be fully satisfactory for burning of the double vee; the use of a 60-deg. angle reduces the amount of weld metal required, as compared to that in the 90-deg. vee still called for by some designers. The 60-deg. vee provides sufficient access for the welding rod to its bottom and, since less weld metal is necessary contraction

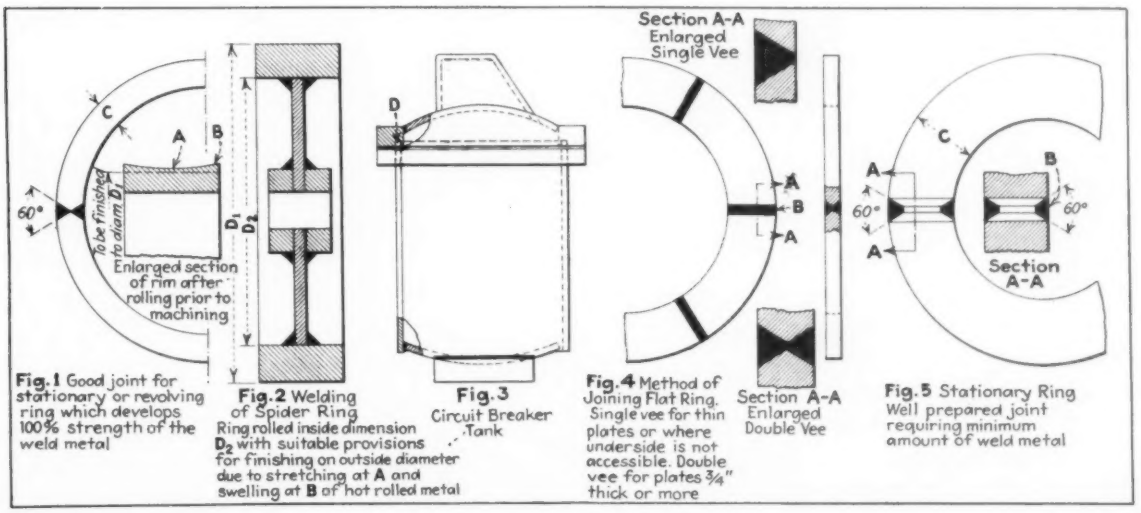


Fig. 1 Good joint for stationary or revolving ring which develops 100% strength of the weld metal

Fig. 2 Welding of Spider Ring. Ring rolled inside dimension D_2 with suitable provisions for finishing on outside diameter due to stretching at A and swelling at B of hot rolled metal

Fig. 3 Circuit Breaker Tank

Fig. 4 Method of Joining Flat Ring. Single vee for thin plates or where underside is not accessible. Double vee for plates 3/4" thick or more

Fig. 5 Stationary Ring Well prepared joint requiring minimum amount of weld metal

stresses are smaller. This design enables the development of the full strength of the weld. It can be used for revolving parts such as a spider for an a.c. generator, Fig. 2. It will also be satisfactory for oil-tight work, such as forming a part of the top of a circuit-breaker tank, Fig. 3.

It should be noted that if this design is used where a tank end is subjected to pressure, it is necessary to make a sealing weld across the double vee end to prevent seepage at its apex, for the band may not always be leak-proof at this point due to lack of penetration in the bottom when starting the second vee. For the same reason a ring, welded as in Fig. 4 with a double vee, would not always be oil-tight with oil pressure applied on the outside or inside diameter where the root of the double vee is exposed, as at *B*.

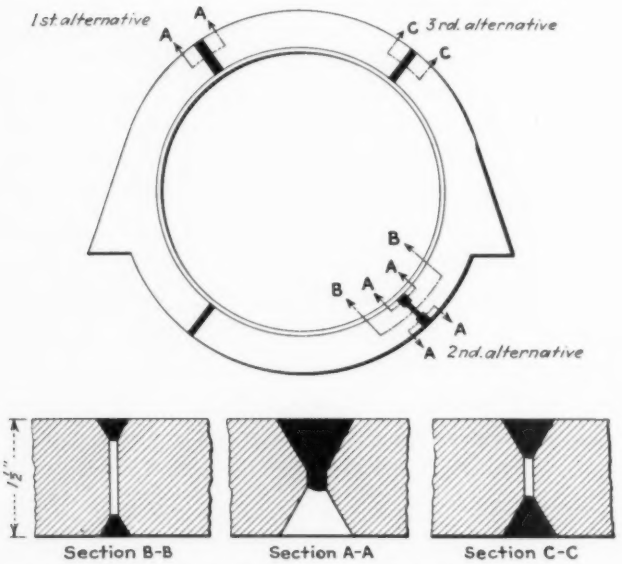


Fig. 6 Side wall of a welded frame built up of segments. Preparation can be simplified and weld metal saved by reducing depth of vees to actual stress requirements

Referring again to Fig. 3, at point *D* a groove is often machined for a joint gasket, and the vee weld must be specified so that when machined out there is no chance of cutting into the region of doubtful penetration which always exists when starting the weld. It requires considerable skill and attention to make a perfect weld there.

In welding, just as in any other work, designs are preferred that can be carried out by a welder with average skill. The problem has been solved by the design in Fig. 5. All four sides are veed to a depth of $\frac{3}{8}$ in. or more, according to the size of the ring and its application. A relatively small amount of weld metal is required. The ring can be machined all over and will present a perfect finished appearance. As discussed under Fig. 3, where a groove is machined the design is so treated as to secure a favorable weld condition to give a good margin for leakage, but if this is done, Fig. 5 is generally the best and cheapest weld design. The same ring, prepared to the design of Fig. 1, would take too much weld metal due to the relatively large dimension *C*. Large flat rings can be produced readily from segments, as shown in Fig. 4, previously discussed in connection with oil-tight welds. The joints can be made to either of the two alternatives of section A-A, using a double vee with less weld metal, or a single vee where the under sides of the plates are not accessible for welding. It should be noted that the vee is cut in the opposite plane from that in Fig. 1. Where machines are available, the design shown in Fig. 4 can be produced by butt-welding up to about $\frac{3}{16}$-in. in thickness, or by single vee with not over 40 deg. total angle up to $\frac{5}{16}$ or $\frac{3}{8}$-in. in thickness.

Using Metal to Best Advantage

The metal in the joints of Fig. 4 is used to best advantage, being massed on both sides of the neutral axis. A similar condition is shown in Fig. 6, which is a frame end for an a.c. machine. For comparison, three alternatives are illustrated. The third and best alternative is identified by section *C-C;* it requires the least amount of weld metal, for the depth of the vee has been made just sufficient to meet the stresses; these are greatest during handling of the frame ends prior to assembly. The first alternative with a vee to the middle of the plate and across the whole width (see section *A-A*), dates back to the liberal use of weld metal in early designs for welding. The second alternative originated in the efforts to reduce the amount of weld metal; the two outer ends of the vee reach to the middle of the plates, while the middle part of the joint has only a shallow vee (Section *B-B*), which closes the gap between the component parts for appearance. Such preparation is expensive, for veeing must be done in three steps by hand burning. Greater accuracy and better economy is possible with machine burning, to which the third alternative design lends itself readily.

When economies in producing rings for stock are considered, further cost reductions can often be made by designing so that welding helps to reduce stock. Wide rings, Fig. 7, subject to moderate axial stresses can be produced on short notice by joining two stock rings along the periphery with a $\frac{3}{8}$-in. deep vee. In special applications the design must depart from the established location of welds. For welded pulleys, Fig. 8,

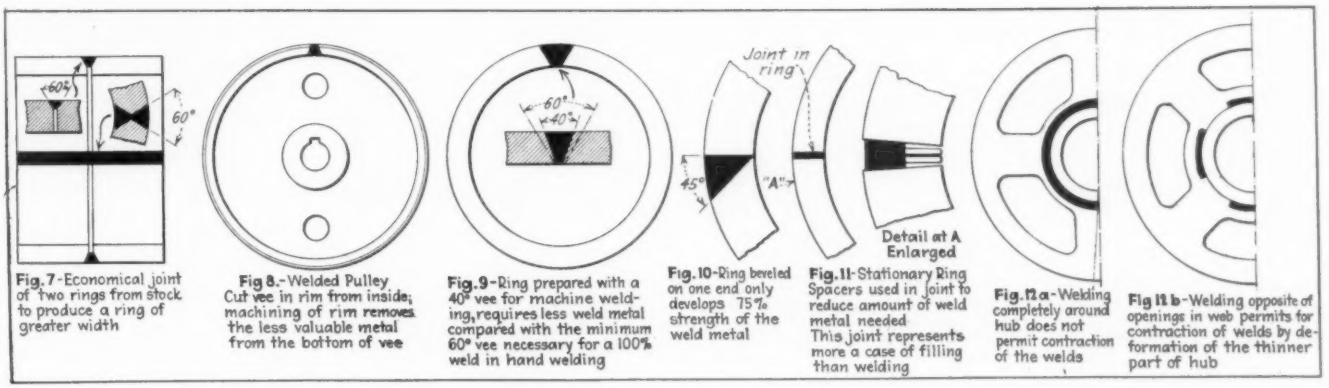


Fig. 7-Economical joint of two rings from stock to produce a ring of greater width

Fig 8.-Welded Pulley Cut vee in rim from inside; machining of rim removes the less valuable metal from the bottom of vee

Fig. 9-Ring prepared with a 40° vee for machine welding, requires less weld metal compared with the minimum 60° vee necessary for a 100% weld in hand welding

Fig. 10-Ring beveled on one end only develops 75% strength of the weld metal

Fig. 11-Stationary Ring Spacers used in joint to reduce amount of weld metal needed This joint represents more a case of filling than welding

Fig. 12 a-Welding completely around hub does not permit contraction of the welds

Fig 12 b-Welding opposite of openings in web permits for contraction of welds by deformation of the thinner part of hub

the vee in the rim should be placed on the inside, otherwise, the best part of it would be machined away during the finishing of the crown. At the time the decision is made about a design, the engineer should know if hand welding or machine welding will be used in the fabrication of the machine parts.

A further reduction of the amount of weld metal is possible in machine welding. Instead of the 60-deg. preparation necessary in most of the rings described previously, a 40-deg. vee is sufficient (see Fig. 9) because penetration at the bottom of the sharper angle is possible with the higher amperage used; this is permitted on account of the short arc uniformly maintained with the automatic feed. In some applications, weld metal is desirable or necessary across the total section, though the full strength of it is not required. In such cases, preparation on one end of the ring is only necessary at a bevel of 45 deg., as shown in Fig. 10. Weld metal is saved, though the joint is only about 75 per cent strong, as with a straight wall perfect fusion is not always fully accomplished except on thin material.

Finally, the design of a ring without any preparation for welding is shown in Fig. 11. The slab has been cut to a suitable length and rolled. The gap left between the two ends will vary somewhat even in the rings of the same size due to variation in stretching of the material in rolling. In order to reduce the amount of weld metal, one or more filler straps are inserted in the gap prior to the welding. The described rings are suitable for d.c. frames of small and medium size. Relatively small stresses are expected in this joint.

The cost of welded products is closely linked with a chain of processes preceding or following the welding. Referring again to Fig. 2, the rim of the spider is a welded ring, finished on the outside diameter. The rim is shown in the enlarged section as it appears after rolling. It is reduced at *A* from its original thickness and swelled at *B*. This reduction in rolling should be taken into account by the designer by making sufficient allowance for finish when specifying the material for the ring. Frequently the ring will have undergone subsequent operations, such as welding in of the arms and the hub, before it is discovered that the outside diameter cannot be made to the dimension expected. Either a part of the rim will remain unfinished or an entirely new ring has to be made.

For castings, such problems of finish were taken care of by the pattern shop and foundry as a matter of established routine, but for welding, such allowances must be studied and provided by the engineer to suit the welding practice followed.

Shrinkage Stresses

In some instances shrinkage stresses can be reduced by placing the welds where some deformation in the parent material is possible. This is not the case with a weld on arm *B* in Fig. 12-A. Instead of continuous welds of smaller size, the larger welds located only along the openings in the web can contract due to the give in the thinner part of the web and clearance existing between the component parts.

[*This article will be completed in the February number of Product Engineering*]

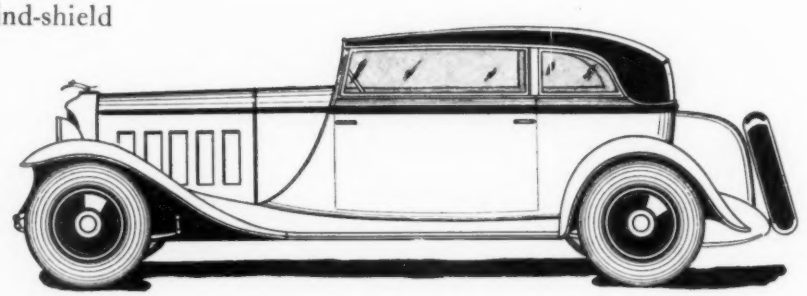
Body Insulation, Colored Tops, but few Mechanical Innovations at New York Salon

Engineers, designers, material and parts manufacturers do well to watch the automobile salons closely because styles are set there that appear in production later

By HERBERT CHASE
Consulting Engineer, New York

NEW YORK'S 1931 Automobile Salon, as in years past, emphasized custom body work, but was not without innovations of a mechanical nature. There were, for example, improved applications of independent wheel springing, new free-wheeling devices, more twelve-cylinder engines, automatic starting equipment and modern ride-control mechanisms.

Chromium plated work, because of its color and freedom from tarnishing, continues in general use on external fittings, including wind-shield frames, radiators, bumpers, lamps and horns. Screen grills in front of radiators have been abandoned in most cases in favor of much more useful and more sightly shutters, frequently controlled by thermostats. Lacquers form the practically universal body finish, and are applied to aluminum as well as to steel panels. Nearly all car and body manufacturers now do a thorough job of body insulation against drumming and other noises, cold and fumes. Cork, rubber, jute, felt, fibre boards, wadding, fabrics, carpet, and plastic mixtures of asphaltum and asbestos, are among the many materials employed for this insulation.



BRUNN sport cabriolet on the new Lincoln chassis. The "Double-entree" door, which is specially hinged to open at either end, is a novelty. Curved lower body lines, shallow windows, pointed radiator and sloping visorless windshield are characteristic of many cars

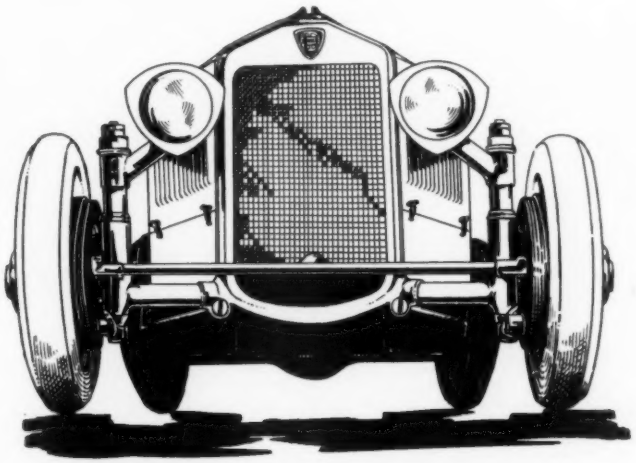
The outstanding mechanical exhibit was the new Lincoln chassis, a noteworthy example of clean-cut, high-grade automotive design. This chassis incorporates a 150-hp., twelve-cylinder V-type engine of 448-cu.in. displacement. Instead of setting the cylinders at a 60-deg. angle to give an absolutely uniform spacing of power impulses, the blocks are arranged at a 65-deg. angle to avoid synchronous vibration periods which might interfere with the high quality of smoothness required in a car in this price class. Although the engine develops its maximum power at 3,400 r.p.m., equivalent to a road speed of 68 miles an hour, the car is said to be good for 85 miles an hour.

Brake operation on the Lincoln and some other large chassis exhibited is rendered easier by a vacuum booster, merely an air cylinder and piston connected through a control valve with the engine inlet manifold. A free-wheeling unit is fitted at the rear of the new gearset. The latter incorporates silent constant-mesh helical gears arranged for engagement by toothed clutches with synchronizing devices to facilitate easy shifting. In most respects this gearset arrangement is similar to that employed on a majority of the American cars at the salon. Lincoln has dropped the free-wheeling design which employed an overrunning clutch inside the gearset itself and required selection of free-wheeling by varying the throw of the shift lever. In the new design the separate free-

wheeling unit is operated by a knob on the instrument panel. Except in reverse, this control stays set in or out of the free-wheeling position.

Pierce-Arrow's new twelve is a seven-bearing, 80-deg. V-type engine and marks a decided departure in the policy of that company, which heretofore has built only in-line sixes and eights. So-called "ride-control," involving adjustments of hydraulic shock-absorber by-pass valves through a lever on the instrument board and a series of rods and links extending to the valves, is a feature of this chassis. Its free-wheeling unit is controlled by an instrument board lever next to that for ride control. The final drive is by hypoid gearing. Duesenberg and Stutz, as well as the Chrysler Imperial, continue with eight-in-line engines, but most other American cars in the high-price ranges, including Cadillac and Marmon, present V-types having twelve or sixteen cylinders.

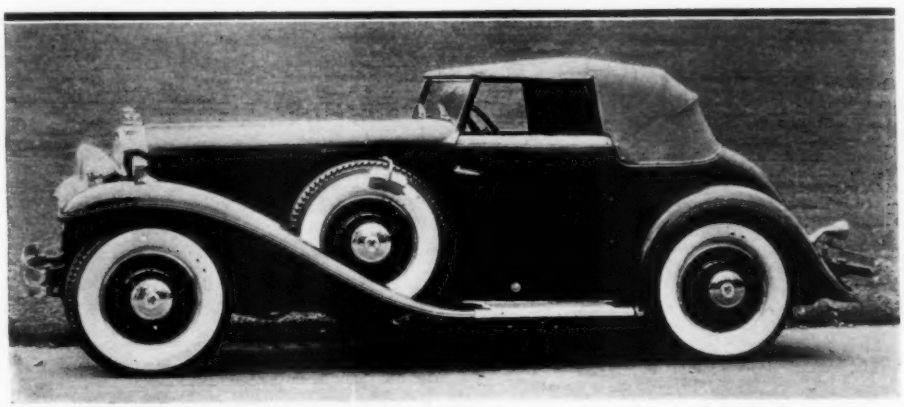
In the Italian Lancia chassis exhibited, the front wheels are not supported on a conventional through axle, but knuckle pivots are carried in telescoping vertical tubes containing helical springs, and are arranged to move independently. The vertical guides are connected by tubular cross-members braced to the frame of the chassis and, of course, constitute a part of the sprung weight. Partly because of the small unsprung weight on the front wheels, riding qualities are said to be materially improved. This is not a new departure for Lancia, but is applied to a larger chassis (with eight-cylinder engine) than that on which it was used originally. Other foreign-built chassis exhibited presented chiefly relatively minor departures from conventional practice. One of these, a Delage, with a cabriolet body, had its front fenders faired back of the wheels to reduce wind resistance at this point, and employed abbreviated running boards.



LANCIA eight chassis with independent springing of front wheels, a possible fore-runner of American developments in new forms of suspension

Body developments included the usual array of novelties, but the majority of models were more conservative. Although bright colors abounded, there were a few pastel tints and many dark or even black bodies, especially among the town cars. For sport models and convertible cars vivid or light colors ruled, and were employed not only on the body itself, but on fenders and tops as well as on superstructures. For the first time in the writer's recollection, collapsible tops were seen in a raspberry color to match an unusual body color, and in a light pea green to harmonize with a darker green body and striped green leather upholstery.

Among American body designers there is a decided tendency to eliminate outside visors, to slope the windshield sharply, and to round the corners where it joins the roof. In some cases the windshield is also pointed and a line of molding is carried down the center, across the hood and down the center of the radiator. The radiator is usually pointed also, and in some cases is sloped backward at the top. These designs present variations but basically are of a type made popular on Cord, Reo and Auburn cars in recent years. Claims are made for substantial reduction in air resistance with such designs, but of course they are far from the "true" streamline.



STUTZ 32-valve "Super-Bearcat" eight chassis with aluminum-paneled Weyman convertible coupe body. This car is said to be capable of traveling over 100 m.p.h.

▼

COMMENT and SUGGESTION

Rotary Pivoted Hammers

By H. M. Plaisted
Mechanical Engineer

A CRUSHING machine with rotary pivoted hammers for crushing rocks to different sizes is shown in Fig. 1. The method of operation is evident from the illustration. The shaft of the hammer mill is direct-connected to the driving motor through a coupling. During rotation of the shaft, the centrifugal force causes the hammers to assume radial positions. When striking a large rock or other material to be crushed, the hammers swing back upon hitting the rock, and the successive blows quickly reduce the rocks to the desired size.

In these crushers, the hammers are usually simple rectangular bars with a square end. In use, the front corner of the outer end soon wears off, further use of the hammer being obtained by reversing its position on the hammer rod, which in this form of crusher is somewhat eccentric to the main shaft that passes through the disk that carries the hammer rods.

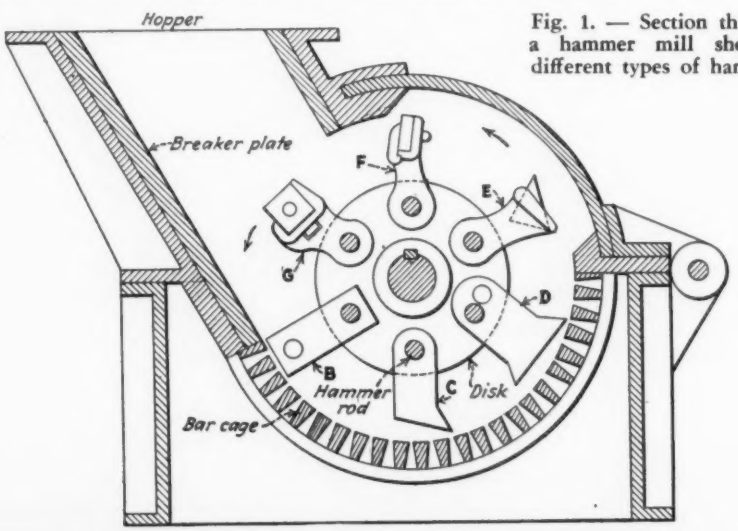


Fig. 1. — Section through a hammer mill showing different types of hammers

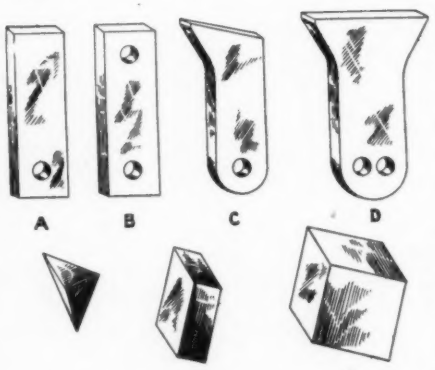


Fig. 2 — By simple modifications, the available cutting edges on the hammer can be increased greatly

In order to increase the life of the hammer between redressings, an improvement was made by drilling a hole at each end of the hammer as shown at *B* in Fig. 2. By reversing the hammer and also mounting it end for end, the number of available corners was doubled.

However, this square end did not provide any clearance, and it dragged upon the material being crushed between the cage and the hammer end. Adopting the principle used in planer tools, a clearance of 15 deg. was provided, and the front point was drawn forward as shown at *C*, thus producing a hammer that gave greatly improved efficiency and operated at less power. It had the disadvantage, however, of providing but one operating corner. An attempt to double the number of operating points by using the form shown at *D*, but with only one hole, proved to be impractical since the rear point was subject to the drag of the crushed material.

To overcome this difficulty and give clearance to each point in succession, a double hole for the pivot rod was provided as shown at *D*, the hammer being mounted by passing the rod through that hole which was at the greatest radial distance from the operating edge. This provided the necessary clearance, and when the front point was worn, the hammer was reversed by passing the hammer rod through the other hole.

At *E* is shown an effective form of hammer tip, it being a triangular pyramid having six edges, any one of which can be brought to the front by changing the position of the tip in the shank. The greatest advantage in the use of tip is that it can be made of expensive and specially hardened alloy steel. The form of tip illustrated is used extensively in crushing and pulverizing coal, but it is equally applicable for other materials of a similar nature.

Another form of tip, with eight edges, is shown at *F*. By mounting this tip suitably in the shank, the block is inclined so as to obtain the required clearance of 15 deg. from the outer operating edge.

A square cube having 12 edges is shown at *G*, the required clearance being obtained by suitably mounting the cube in the shank. This 12-edge square cube seems to be the limit for the number of edges that can be practically provided for hammers used on these machines. The principal advantage of this cube construction is the great amount of cutting edge which may be obtained with a relatively small tip. For example, a cube 3 in. on an edge will provide practically 33 in. of cutting edge by successive adjustment of the tip in its holder. The slight loss of 3 in. over the theoretical 36 in. is because the corners become rounded when adjacent edges are worn to a rounded condition.

Right Triangle Problems

By Irving A. Hunting

IF in the usual right triangle formula:

$$a^2 + b^2 = c^2$$

we make $b = c - d$, then it can readily be shown that:

$$c = \frac{a^2 + d^2}{2d} \qquad (1)$$

Assuming a series of right triangles in which $d = 1$, we have that $c - b = 1$. From Equation 1:

$$c = \frac{a^2}{2} + \frac{1}{2}.$$

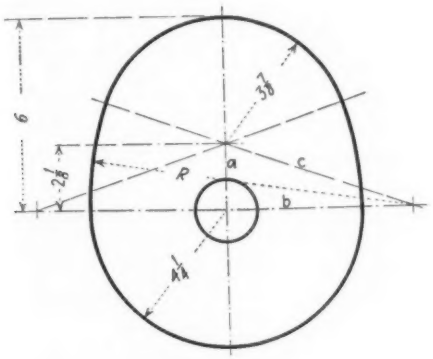
Also, as $b = c - 1$,

$$b = \frac{a^2}{2} - \frac{1}{2}.$$

Adding the equations 2 and 3, we get:

$$a^2 = c + b$$

To illustrate the use of these formulas, consider the cam shown herewith, which has been laid out with



two eccentric curves for the rise, one of which with $3\frac{7}{8}$ radius, has been scaled from the layout. R is to be figured to correspond exactly. Taking the triangle $a\,b\,c$, we have:

$$a = 6 - 3\frac{7}{8} = 2\frac{1}{8}$$

$$c = R - 3\frac{7}{8}$$

$$b = R - 4\frac{1}{4}$$

Subtracting these last two equations,

$$c - b = \frac{3}{8} = d$$

Substituting in Equation 1, we have:

$$c = \frac{a^2 + d^2}{2d} = \frac{\left(2\frac{1}{8}\right)^2 + \left(\frac{3}{8}\right)^2}{2 + \frac{3}{8}}$$

From which:

$$c = 6\frac{5}{24}$$

$$R = c + 3\frac{7}{8} + 6\frac{5}{24} + 3\frac{7}{8} + 10\frac{1}{12}$$

The same result might have been obtained by dividing the sides of the triangle by $\frac{3}{8}$, which would make

$$a = 17/3$$

and $$c - d = 1$$

This would give $c = 16\frac{5}{8}$, which multiplied by $\frac{3}{8}$, to restore the original triangle, would make

$$c = 6\frac{5}{24}$$

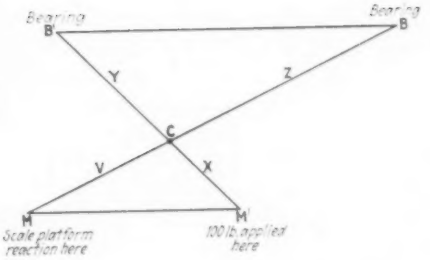
This checks with the answer as obtained above.

Paradoxical Dynamometer

By Frederick Franz

Engineer

EXCEPT for the incorrect use of the word "fulcrum," the reasoning in the "Dynamometer Paradox" of



the November, 1931, number is correct. The mistake is the statement: "the load on the scales L will be represented by $\frac{Z}{V+Z}\,\frac{(100+100X)}{Y}$ instead of 100 pounds as generally believed."

It can be proved algebraically that numerical quantities substituted for the symbols in the equation, the result will be 100 pounds. In the plan view as shown in the accompanying figure, are two similar triangles,

MORE or LESS SERIOUS

GAS-CUT FRAMES

Machine gas cutting first appeared in 1906, but it is only lately that it has been adopted widely for cutting out machine frames and parts from steel plate. L. M. Curtiss of the Lukens Steel Company, gave a most interesting talk at the I.A.A. convention in Chicago on November 13 in which he shows that while the physical changes in the cutting zone of the steel leave a thin hardened edge this presents no difficulty to working the steel later. The method is worth the investigation of the designer of heavy machinery.

•

AGRICULTURAL MACHINES

Distributing machines for commercial fertilizers are badly needed, according to a statement of G. A. Cumings of the U. S. Department of Agriculture. These machines must deliver the fertilizer uniformly in proper relation to the plant, and the mechanism must be easy to adjust and clean. Here is a chance for some designer!

•

CONSIDER THE MECHANIC

Said an automobile mechanic while he was replacing a storage battery: "I have never been able to figure out why the automobile manufacturers put a hole in the floorboard not quite big enough so that you could take out the storage battery without first taking out the floor of the car. A few more inches each way in the size of the opening, and it would not be necessary to take all the screws out and lift out the floor.

This reminds us of the story of the old maid whose cat had kittens. In order to allow the animals to go in and out, she had a large opening cut through the door to permit the cat to go out, and a small opening cut in for the kittens.

•

MECHANISMS

Judging by the comments received after publication of the two-page spread on "Door and Cover Fastenings" in the November number, there is apparently great interest in assembled material on mechanisms. More will be forthcoming in future numbers of *Product Engineering*.

•

TRANSPORTS OF THE FUTURE

"A decisive step forward in lighter-than-air history" is what Assistant Secretary of the Navy Ingalls calls the Akron. He foresees the airship as the forerunner of great commercial fleets of air liners. There are others who look to the big heavier-than-air planes as most likely as commercial liners. Perhaps both sides are right.

•

MACHINE NAMEPLATES

One chief engineer reports that he is calling for stainless steel nameplates to be used instead of brass on his machine tools. Why didn't someone do it before?

$CB'B$ and $CM'M$. From these triangles:

$$\frac{V}{Z}=\frac{X}{Y}$$

and

$$\frac{Z}{V+Z}=\frac{Y}{X+Y}$$

substituting $\frac{Y}{X+Y}$ for $\frac{Z}{V+Z}$ in the author's equation for the load on the scales, and simplying these expressions we get

$$\text{Load on scales} = \frac{Y}{X+Y}\left(100+\frac{100X}{Y}\right)$$

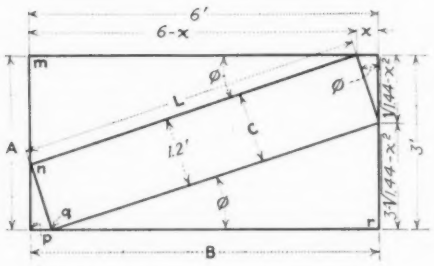
$$= \frac{Y}{X+Y}\,\frac{(100Y+100X)}{Y}$$

$$= \frac{Y}{X+Y}\,\frac{100Y+100X}{Y}$$

$$= 100 \text{ pounds.}$$

The discrepancy observed by the author can only be explained by an improper reading in obtaining the test data.

Solving the Inscribed Rectangle



Length L may be calculated by using Horner's method to solve the fourth degree equation, or a simple cut and try method may be used

FOLLOWING are some of the replies received in answer to the problem presented on page 517 of the November, 1931, number of *Product Engineering:*

SOLUTION BY JOHN E. PRION
Pittsburgh Gear & Machine Company

Referring to the accompanying diagram, we have

$$\tan\phi=\frac{x}{\sqrt{1.44-x^2}}$$

$$\text{Also, } \tan\phi=\frac{3-\sqrt{1.44-x^2}}{6-x}$$

$$\frac{x}{\sqrt{1.44-x^2}}=\frac{3-\sqrt{1.44-x^2}}{6-x}$$

This last equation reduces to:

$$x^4-6x^3+9.81x^2+4.32x-2.7216=0$$

Solving this equation by using Horner's method to find one positive real root, we find that $x = 0.377$, to nearest three decimal places. Therefore x in the diagram equals 0.377 ft.

$$\sin\phi=\frac{.377}{1.2}=0.31417$$

$$=\sin 18^\circ 19', \text{ approximately}$$

$$\text{And, } L=\frac{6-x}{\cos\phi}=\frac{5.623}{.9493}=5.923 \text{ ft.}$$

SOLUTION BY MANIOUS GOTTLIEB

Setting up the equation in a similar manner as above, and solving by Horner's method, the calculated length of the inscribed rectangle is 5.85 ft.

SOLUTION BY D. E. HOBART

Solving by a method similar to that presented above, and using Horner's method for solving the fourth degree equation, the length of the inscribed rectangle is 5.915 ft.

SOLUTION BY W. W. JOHNSON
Trundle Engineering Company

Mr. Johnson dealt with the trigonometric relations of the angle ϕ shown on the figure accompanying Mr. Hubbell's presentation. From this he established his fourth degree equation, solved it by Horner's method and computed the length of the inscribed rectangle as being 5.923 ft.

SOLUTION BY CLINTON C. HUBBELL

The following cut and try method is suggested by Mr. Hubbell, who presented the problem. Referring to the above figure, let m, n, p, q and r indicate corners of the right triangles formed between the inside and outside rectangles.

Let ϕ be the acute angle of the triangles, which by construction are similar.

Hence, $A=mn+np$,

$B=pq+qr$

Or $A=L\sin\phi+C\cos\phi$

and $B=C\sin\phi+L\cos\phi$

$$L=\frac{A-C\cos\phi}{\sin\phi}$$

$$L=\frac{B-C\sin\phi}{\cos\phi}$$

Or

$$\frac{A-C\cos\phi}{\sin\phi}=\frac{B-C\sin\phi}{\cos\phi}$$

$$A\cos\phi-C\cos^2\phi=B\sin\phi-C\sin^2\phi$$

$$A\cos\phi-B\sin\phi=C\cos^2\phi-C\sin^2\phi$$

$$=C(\cos^2\phi-\sin^2\phi)$$

But according to trigonometry

$$\cos^2\phi-\sin^2\phi=\cos 2\phi$$

Therefore $A\cos\phi-B\sin\phi=C\cos 2\phi$

Or $A\cos\phi=B\sin\phi+C\cos 2\phi$

This last equation is used to practical advantage in making a numerical solution. From a sketch of the problem made to scale, an estimate of the value of the angle ϕ is made. The value of the angle is then assumed a little smaller than that as measured, and this value substituted in the equation. Repeated trials are then made using slightly increasing values for the angle ϕ until the equation is satisfied.

In this example, the following values were used for the angle ϕ:

18 deg.

18 deg. — 15 min.

18 deg. — 18 min.

18 deg. — 18 min., 30 sec.

It was found that the nearest value for ϕ is 18 deg. — 18 min., 30 sec. This value of ϕ was then substituted in the equation:

$$L=\frac{B-C\sin\phi}{\cos\phi}$$

Which gives:

$$L=5.923 \text{ ft.}$$

If the inscribed rectangle were to have rounded corners, the procedure would be to calculate the dimensions of a rectangle passing through the centers of the radii at the corners. The calculation would then proceed in exactly the same manner as set forth above, and the computed length would be increased by twice the radius at the corners.

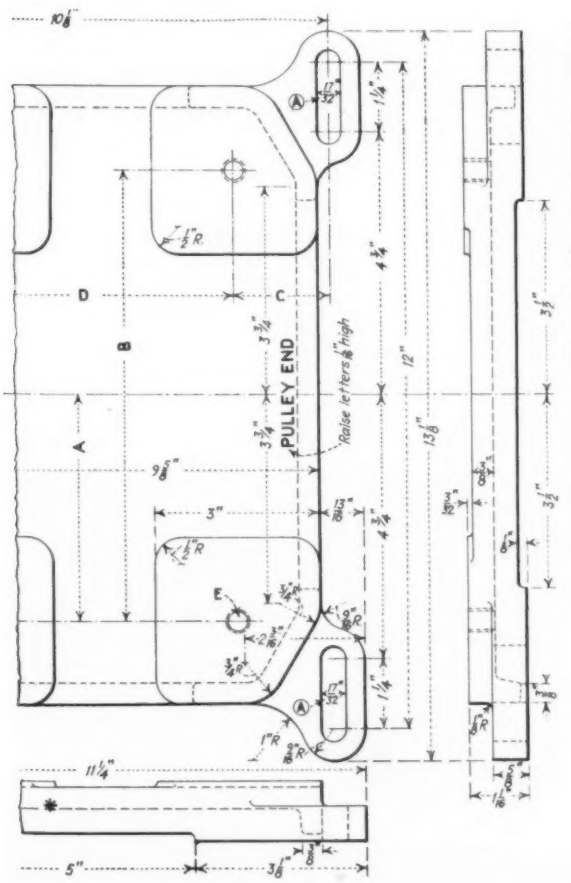
Motor Standardization Greatly Needed

By Charles Harmon

HOW many more years must large buyers of electric motors wait before a logical and convenient set of mounting dimensions for the common sizes of these motors will be standardized? Today there are undoubtedly thousands of special motor base castings or drillings necessary simply because motors of the same type and power are not interchangeable. Even a.c. and d.c. motors of the same make and size (power) are not interchangeable on the same base in many instances. If each of a half-dozen purchasers of a given machine arranged for motor drive happen to specify a different make of motor when the machine is ordered, its builder may require six different patterns and as many different castings to adapt each of these motors to his machine. Surely, the various societies and other organizations charged with standardization work cannot permit this absurd situation to continue indefinitely.

A good example of what results when such a condition continues is that of the motor base used by one large maker of small refrigerating machines. The accompanying drawing and table of dimensions show that no less than sixteen different sets of drillings are necessary to adapt five different makes of motors in the three common sizes: ¾, 1 and 1½ hp., to a given base. In this case it happens that the particular motors used must have their feet extended somewhat more than is common to accommodate large rubber washers intended to absorb vibration, but the requirements for all motors are the same in this respect. Yet instead of comparing dimensions and striving to arrive at a common standard set of dimensions, each motor manufacturer appears to have proceeded alone with the result that no two have the same dimensions or bolt hole spacing. Even the size of the tapped bolt hole varies. Of the five makers, three use ⅜ in.-16, one uses ½ in.-13, and the fifth uses both sizes. Fortunately screw standardization has gone a long way, otherwise it is probable that the number of threads per inch chosen would not have been the same.

Information on shaft height is not given, for in this case the drive is by belt, and the shaft height is not an important consideration. In cases where a direct drive is employed, however, this unstandardized dimension enters. The result is that the height of base pads has to be varied or shims of various thicknesses must be employed. Still another dimension that gives trouble for lack of standardization is the one controlling the axial location of a pulley or gear in relation to the base. Shaft diameter and keyway sizes also need standardization. Motor manufacturers certainly have a long way to go in the direction of standardization. A start has been made, but progress is much slower than it would be if everybody concerned would decide to get the job done.



MOTOR		A	B	C	D	E
Delco	¾ hp. DC	4	8	1⅝	5¾	⅜-16
	¾ hp. RI	4	8	2 1/16	5½	⅜-16
	1 hp.	4½	9	1 11/16	7	⅜-16
	1½ hp.	4½	9	1 11/16	7	⅜-16
General Electric	¾ hp.	3¾	7½	1	6	½-13
	1 hp.	3¾	7½	1	6⅞	½-13
	1½ hp.	4½	9	1 9/16	7	½-13
Wagner	¾ hp.	4	8	2 13/32	4 3/16	⅜-16
	1 hp.	4	8	2 13/32	4 3/16	⅜-16
	1½ hp.	4	8	2 5/16	7¼	⅜-16
Dayfan	¾ hp.	3¾	7½	1 15/16	4	⅜-16
	1 hp.	3½	7	1 23/32	4¾	⅜-16
	1½ hp.	4 3/8	8¾	1⅞	5½	½-13
Westinghouse	¾ hp.	3 5/16	6 5/8	2 17/32	5	⅜-16
	1 hp.	3 5/16	6 5/8	2 17/32	5	⅜-16
	1½ hp.	4 3/16	8 3/8	1½	6½	⅜-16

Stamp symbol of motor for which base is drilled in location ✱ on top of base. Find symbol of motor in table below

MAKE	HORSEPOWER		
	¾	1	1½
General Electric	GE ¾	GE 1	GE 1½
Wagner	WA ¾	WA 1	WA 1½
Dayfan	DA ¾	DA 1	DA 1½
Westinghouse	WE ¾	WE 1	WE 1½
Delco	DE ¾	DE 1	DE 1½

Absence of standardization in motor dimensions requires cumbersome drawings such as this one, and makes complete interchangeability impossible

Move the Decimal Point

By Ross J. B. Rigdon

IN the article by H. F. Vickers, "How to Design for Hydraulic Operation," in the December, 1931, number of *Product Engineering*, there is an error on page 554 in that the constant in the equation near the top of the page should be 0.000583 instead of 0.0000583. However, the answer given namely 2.9 is correct, although if the equation were worked out for the constant given, the answer would be 0.295. In other words, there should be three zeros following the decimal point instead of four as given.

"Redesigning Trial Models" Credit Note

REGARDING the article "Redesigning Trial Models" published in the July, 1931, number of *Product Engineering*, the pictures and accompanying captions of the insulating machines were used only to illustrate a single-purpose machine, such as special machinery manufacturers may be called upon to handle. The original design and all the subsequent modifications were made by the Western Electric Company. A number of these machines were manufactured by the Elevator Supplies Company and are in use in the Western Electric shops.

WHAT'S GOING ON

ENGINEERING NEWS • TRENDS IN METAL PRICES • MEETINGS

STANDARDS and research sessions will be included in the program of the annual meeting of the Society of Automotive Engineers, to be held at the Book-Cadillac Hotel, Detroit, Jan. 25-29. A general session will be sponsored by the National Committee, preceded by a dinner at which the Detroit section will act as host. The Passenger-Car Activity is sponsoring three technical sessions, at which consideration will be given to front-wheel alingment, bearings and chassis matters. Other sessions, sponsored by the various Activities, will be devoted to problems of passenger-car bodies, transportation and maintenance, motor-coaches and motor-trucks, aircraft, Diesel engines and production.

Included in the program for the Passenger-Car sessions are papers on: Front-End Engineering in Relation to the Service-Field Situation, by C. P. GRIMES; Geometry of the Front End, by W. R. GRISWOLD; and an Analysis of the Work and Conclusions of the Front-Wheel-Alignment Research Subcommittee, by J. M. NICKELSEN. Bearings and their problems will be discussed from three viewpoints at a symposium by D. P. BARNARD, 4th, Standard Oil Co. (Indiana); J. V. O. PALM, Cleveland Graphite Bronze Co.; and ALEX TAUB, Chevrolet Motor Co.

SIR DENNISTOWN BURNEY, internationally known British designer of streamlined cars and aircraft, will speak at the meeting on streamlining and rear engine mounting. N. F. HADLEY, R. K. LEE and R. N. JANEWAY, all of the Chrysler Corp., will discuss the "floating power" engine mounting, Mr. Hadley from the production angle, the other two from the technical side of the design. DR. FRED A. Moss will report on riding-qualities research, and two papers will be presented on body design.

Some 2,500 engineers registered for annual meeting of the A.S.M.E., in New York City, at which the election of CONRAD N. LAUER as president was announced. His nomination, as well as that of the other officers, was announced last summer. Only one ticket is nominated, hence no changes occur.

The society's gold medal was awarded to ALBERT KINGSBURY, president of the Kingsbury Machine Works for research and development work in lubrication. Mr. Kingsbury also won one of the three John Scott medals "for the invention of a thrust bearing for use in ships and heavy machinery." Other John Scott medal winners were ALBERT H. EMERY, JR., "for the invention of the Southark-Emery testing machine, a mechanical device for testing materials," and WILLIS H. CARRIER of the Carrier Corporation "for the invention of process and apparatus for cleaning, purifying, and humidifying the air." The Melville Medal was awarded to ARTHUR E. GRUNERT of Chicago. Honorary memberships were awarded to DR. PALMER C. RICKETTS and CALVIN W. RICE.

A meeting was called by RALPH E. FLANDERS, Chairman of the A.S.M.E. Special Research Committee, to point out the present status of this committee and to crystallize plans for future work.

With the publication of PROF. EARLE BUCKINGHAM'S report on "Dynamic Loads in Gear Teeth" one step in the committee's work was concluded. The machinery for further research is available. Prof. Buckingham has expressed a willingness to extend his experiments. The immediate problem is to decide just what direction this work should follow.

Among the suggested possibilities for further study are: (1) measurement of the intensity of the dynamic loads on the different gears of a train, on helical gears, on beveled gears, and on worm gears; (2) investigation of compressive fatigue limits on various gear materials; (3) investigation of design factors on performance of non-metallic materials; and (4) friction losses in gears. Additional topics brought up for study were noise in gear trains and the lubrication of gears.

The Steel Founders Society of America, at its December meeting in Pittsburgh, adopted a report of the special committee on A.R.A. specifications definitely committing the Society to exclusive adherence of casting specifications as promulgated by the A.S.T.M. This action followed the voicing of opposition to changes in the required tensile properties for railway castings. The adopted recommendation states that such a commitment would not obligate any member of the Society to refuse to manufacture materials according to more impressive combinations of physical properties than are found in any A.S.T.M. or other national recognized specifications. However, it would mean higher prices for castings made to these different specifications.

A representative collection of machinery will be one of the features of the British Industries Fair, to be held at Castle Bromwich, Birmingham, England, from Feb. 22 to March 4.

Hooved Donates $5,000 To Engineers' Relief

PRESIDENT HOOVER has donated $5,000 to the Professional Engineers' Committee on Unemployment "with no particular restrictions as to its use." Mr. Hoover commended the work of the Committee and expressed interest in the small loans plan for relieving distress in individual cases.

The committee has raised more than $19,000 in cash and has received pledges for a considerable sum in addition. Approximately 680 engineers have registered, of which about 300 are reported destitute. Jobs have been found for 149.

The Committee, with headquarters in the Engineering Societies' Building, was organized by the four National Engineering Societies. It is estimated that more than $200,000 will be required to carry out the relief program. Donations are being solicited.

News of the Metal Markets

COPPER reached a fairly stable price at about 6½c. in November and remained there during the first weeks in December. Sales were in small volume, according to *Metal and Mineral Markets*. There is no published information on present stocks of the metal, but it appears that an accumulation may proceed even with the projected curtailment of production. One foreign producer estimates that costs are about a cent above present sales prices. An effort to get better prices is expected when the curtailment plan is announced.

TIN prices eased off in early December, Straits tin selling at 20½c., a new low. However, there was not much buying at this price, consumers apparently being well supplied for present needs.

LEAD markets have been very steady but the sales have been dull. Production of the metal is now at a lower rate than in November. The price, New York, during the first half of December was 3.85c., but sales in the London market, when reduced to an American gold basis, have been as low as 2.25c.

ZINC shipments have been constant during the last three months and the price has remained steady. A slight advance to 3.175c. was noted during the second week in December. Demand for High-Grade picked up with an entry of the brass manufacturers into the market.

ALUMINUM commercial ingot, 99 and 98 per cent, was quoted at 28.30c. Dec. 15. No. 12 alloy was at 22c. The remelt aluminum market has been firm, 98@99 per cent ingot selling at 17 to 18c.

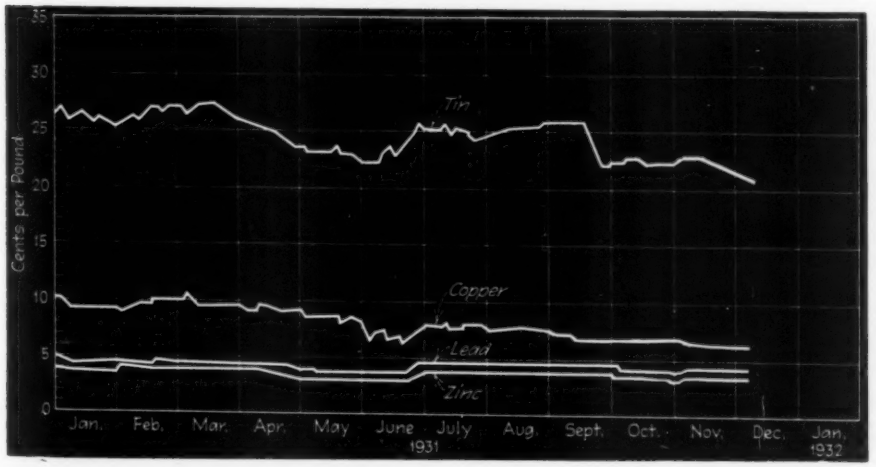
BRASS ingot business is quiet, specifications are light and inventory-taking indicates that little increase in sales is to be expected. Prices are holding fairly even, varying from 5¼c. for No. 1 yellow to 7⅝c. for 85-5-5-5 ingot in carload lots. Exporters are outbidding domestic consumers for copper and brass scrap.

BERYLLIUM, 98 per cent pure and containing about 1 per cent iron and a little combined slag, is being produced in greater quantities by Siemens & Halske, A. G., Berlin. Consequently, prices have been lowered from $100 to $81 per lb. Metal 99.5 per cent pure is quoted at 66c. a gram. Beryllium alloys are quoted on the basis of the Be content at 750 marks per kilo plus the current value of the alloyed metal and the mixing costs.

Standards and Specifications

A proposed revision of Federal Specification No. 290a, for Bronze Ingots, has been submitted under No. QQ-B-701. QQ-C-521 on Copper Ingots has been submitted to industry as a proposed revision of No. 120, QQ-N-301 on Nickel for Remelt Zinc as a revision of No. 371. QQ-T-371 on Pig Tin as a revision of No. 90, QQ-C-581 on Silicon Copper as a revision of No. 119, and QQ-C-571 on Phosphor Copper as a revision of No. 118. QQ-M-151 for the Inspection of Metals to succeed 339a, QQ-T-351 on Phosphor Tin to succeed USGMS116, QQ-2-351 on Slab Zinc (Spelter) to succeed USGMS91a, and a new specification, WW-T-711, on Seamless Aluminum-Manganese Tubing.

Center-to-face dimensions for ferrous flanged valves, recently developed and approved by the Manufacturers Standardization Society of the Valve and Fittings Industry as standard practice, have been tentatively recommended for adoption as an American Standard. The proposal sets forth center-to-face dimensions of cast-iron and steel-flanged valves of the wedge gate, globe and angle types over several pressures and over a considerable range of sizes.



Meetings

American Road Builders Association—Annual meeting and exposition, Detroit Airport, Jan. 9-15. Charles M. Upham, secretary, 938 National Press Bldg., Washington, D. C.

National Automobile Show — New York, Grand Central Palace, Jan. 9-16; Chicago, Coliseum, Jan. 30-Feb. 6.

American Engineering Council — Annual meeting, Mayflower Hotel, Washington, D. C., Jan. 14-16. L. W. Wallace, executive secretary, 744 Jackson Place, Washington.

Steel Founder's Society of America, Inc.—Annual meeting, Chicago, Ill., Jan. 21, 1932. G. P. Rogers, managing director, 932 Graybar Bldg., New York City.

National Association of Engine & Boat Manufacturers—Motorboat and Marine engine show, Grand Central Palace, New York City, Jan. 22-30, 1931. Henry R. Sutphen, president.

Society of Automotive Engineers—Annual meeting, Book-Cadillac Hotel, Detroit, Mich., Jan. 25-29. John A. C. Warner, secretary, 29 West 39th St., New York.

American Institute of Electrical Engineers—Annual Winter meeting, Engineering Societies Bldg., New York, N. Y., Jan. 25-29. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

Second International Heating & Ventilating Exposition—At Cleveland Municipal Auditorium in connection with annual convention of the American Society of Heating & Ventilating Engineers and joint meeting with American Society of Refrigerating Engineers at the Hotel Cleveland, Cleveland, Ohio, Jan. 26-29, 1932. Secretary, David L. Fiske, 37 West 39th St., New York City.

British Industries Fair—Castle Bromwich, Birmingham; and White City and Olympia, London, England, Feb. 22-Mar. 5. Displays and exhibits will cover all sorts of equipment and machinery, both for industrial and domestic use.

Southwest Road Show & School—Seventh annual, Wichita, Kan., Feb. 23-26, 1932. Including exhibits of road machinery and equipment. Inquire Southwest Road Show & School, Wichita, Kan.

American Management Association—Packaging, packing, and shipping exposition, Palmer House, Chicago, Ill., Mar. 7-12, 1932. W. J. Donald, managing director, Room 602, 225 West 64th St., New York, N. Y.

American Society of Bakery Engineers—Annual meeting, Edgewater Beach Hotel, Chicago, Mar. 14-17. Includes exhibits of bakery machinery. Victor E. Marx, secretary, 1541 Birchwood Ave., Chicago.

American Railway Engrg'g Ass'n—Annual meeting, Palmer House, Chicago, Ill., Mar. 15-17. E. H. Fritch, secretary, 59 East Van Buren St., Chicago.

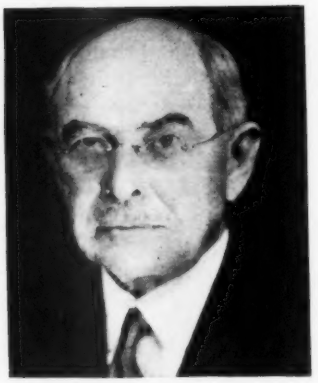
Knitting Arts Exposition—28th annual show of textile machinery, Commercial Museum, Philadelphia, Pa. April 11-15.

American Oil Burner Ass'n—Annual meeting and exposition, Boston, Mass., April 11-15. Harry F. Tapp, secretary, 342 Madison Ave., New York City.

Electrochemical Society — Spring meeting, Baltimore, Md., April 21-23. Colin G. Fink, secretary, Columbia University, New York City.

American Foundrymen's Ass'n—36th annual convention and exhibition, new Municipal Convention Hall, Philadelphia, Pa., May 2-6. Executive secretary, 222 West Adams St., Chicago.

Engineers and their Doings



Edwin W. Rice, Jr.

W. T. Donkin

Everitt J. Cole

DR. EDWIN WILBUR RICE, JR., honorary chairman of the board of the General Electric Co., Schenectady, N. Y., will be awarded the 1931 Edison Medal for "his contributions to the development of electrical systems and apparatus and his encouragement of scientific research in industry." The medal will be awarded at the annual convention of the American Institute of Electrical Engineers, Jan. 25-29. It was instituted by friends and associates of Thomas A. Edison and is given annually for "meritorious achievement in electrical science, electrical engineering, or the electrical arts." It is made by a committee of twenty-four members of the Institute. Dr. Rice is the inventor of the present fundamental form of high-voltage oil separating buses and circuits, as well as the application of synchronous converters to the building of unified alternating and direct current distribution systems. He was responsible for the adoption by the General Electric of the Curtis steam turbine and for the establishment of the research laboratory.

W. T. DONKIN, formerly chief engineer of the Cleveland Wire Spring Co., has become assistant general manager of the coil-spring division of the Eaton Spring Co., Detroit. H. H. CLARK, formerly a member of the sales and engineering staff of the Cleveland Wire Spring Co., stationed in Detroit, has become chief engineer of the coil-spring division of the Eaton Spring Co.

EVERITT J. COLE, chief chemist of the Hilo Varnish Corp., Brooklyn, N. Y., has been appointed industrial sales manager, as announced last month. Mr. Cole is an expert on finishes for metal products and has been a frequent contributor to *Product Engineering*.

ROBERT M. ARNOLD, chief engineer of the radio division, Grigsby-Grunow Co., has been elected 1932 vice-chairman of the Chicago section, Institute of Radio Engineers. At the latest meeting, E. W. RITTER, head of tube development work for R. C. A. Radiotron Co., Inc., Harrison, N. J., spoke on "The Use of Suppressor Grids in Pentodes."

J. B. BERRYMAN, first vice-president of the Crane Co., Chicago, Ill., has been elected president to succeed the late R. T. CRANE, JR.

DORSEY L. BOTHAM has become engineer with the Wisconsin Foundry & Machine Co., Madison, Wis.

ROBERT CHRISTMAN, formerly experimental engineer of the Oakland Motor Car Co., has joined the Chrysler Corp. engineering research staff.

R. E. COLE is chief engineer of the Rockne Motors Corp., Detroit, Mich., a subsidiary of the Studebaker Corp., South Bend, Ind., which is producing the new "Rockne" automobile. Mr. Cole has been a member of the engineering organizations of the Chalmers Co., the Saxon Motor Car Co., the Liberty Motor Car, and Continental Motors.

KENNETH H. CONDIT, publishing director and editor of *Product Engineering* and *American Machinist*, has been appointed to represent the American Society of Mechanical Engineers on the American Standards Association Sectional Committee on Preferred Numbers and on the American Standards Council.

R. Y. COPLAND, formerly director of the planning and engineering department of the Dominion Rubber Co., Ltd., Kitchener, Ont., Canada, has become factory manager.

D. W. DEAN has been appointed manager of the Control Section of the Industrial Department of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. He will succeed the late W. H. MacGillivray. Mr. Dean has been connected with Westinghouse since 1921 and prior to that was in the electrical department of the Buckeye Steel Castings Co., Columbus, Ohio.

CARL J. FECHHEIMER, electrical engineer, has opened an office as consultant in the Title Guaranty Bldg., Milwaukee. He will specialize on design and thermal problems, principally concerned with electrical machinery.

CHRIS J. FIELDS, formerly a layout man in the body department of the Pierce-Arrow Motor Car Co., Buffalo, has accepted a similar position with the Edward G. Budd Mfg. Co., Detroit.

ALFRED A. GASSNER, formerly chief engineer of the Fokker Aircraft Corp., Hasbrouck Heights, N. J., is now acting as an independent aeronautic engineering consultant in New York City.

WALTER M. HARTUNG, formerly engineer for the Aircraft Improvement Corp., New York City, has become dean of aviation at Beckley College, Harrisburg, Pa.

HALL H. HIBBARD, for several years project engineer with the Stearman Aircraft Co., Wichita, Kansas, has accepted a similar position with the newly formed Stearman-Varney Aircraft Co., Alameda, Calif.

ROBERT N. JANEWAY, connected for the past year with the Chrysler Corp., Detroit, Mich., in a consulting capacity requiring only part time, is now permanently connected with the corporation as consulting engineer in the research division in association with R. K. LEE, director of research.

CHARLES O. GUERNSEY, chief engineer of the automotive car division of the J. G. Brill Co., Philadelphia, Pa., has been advanced to chief engineer of

the company. He had held the former position since 1923, before which he had been connected for eight or more years with the Service Motor Truck Co., of Wabash, Ind. During the World War Mr. Guernsey was captain and chief draftsman in the engineering section of the motors division of the Quartermaster's Department in the City of Washington, D. C.

O. T. KREUSSER, formerly director of the General Motors Proving Ground at Milford, Mich., and during the past year in charge of engineering tests for the Fisher Body Corp., division of General Motors, has been appointed director of the Museum of Science and Industry, Chicago.

W. C. HEATH, vice-president of Fairbanks Morse Co., Beloit, Wis., in charge of manufacturing, resigned Nov. 1 to join the A. O. Smith Corp., Milwaukee as vice-president in charge of research, engineering and manufacturing. He will correlate the research and engineering branches with the factory production program. Mr. Heath had been with Fairbanks Morse since 1909, when he joined the engineering staff. Since 1927 he has been in charge of all manufacturing operations in the company's factories. A. W. THOMPSON has been appointed vice-president in charge of manufacturing operations of Fairbanks Morse to succeed Mr. Heath. An engineer by education, he has spent considerable time in the sales branches of Fairbanks Morse and General Electric.

WILLIAM H. HIGHAM, formerly engineer with the Bijur Lubricating Corp., Long Island City, N. Y., has become a fuel engineer with the Vacuum Oil Co. of South Africa, Ltd., but will be located temporarily in New York City.

E. W. TEMPLIN, at one time chief engineer of the Six Wheel Co., Philadelphia, and later supervisor of design and construction of special equipment for the Graham Bros. Division, of the Chrysler Corp., Detroit, has been made chief engineer of the Curtis Mfg. Co., Los Angeles, Calif.

HANS HODGEMANN, formerly engineering draftsman with the Electro-Dynamic Co., of the Electric Boat Co., Bayonne, N. J., has become a designer with the Edward G. Budd Mfg. Co.

FRANK JARDINE, chief engineer of the Cleveland plant of the Aluminum Co. of America, spoke before the Metropolitan section, S.A.E., Nov. 19 on "The Possibilities of Light Alloys in Motor Vehicle Construction."

DONALD DE LACKNER, formerly construction engineer with the Sikorsky Aviation Corp., Bridgeport, Conn., has become a designer in the engineering department of the American Airplane & Engine Co., Farmingdale, N. Y.

CARLETON JOHN LAUER, formerly chief engineer and manager of the refrigeration division of Brooks Steam Motors, Inc., Buffalo, N. Y., has become experimental engineer with the A. C. Spark Plug Co., Flint, Mich.

Charles O. Guernsey

O. T. Kreusser

E. W. Templin

ROBERT P. LAY, formerly assistant chief engineer of the H. H. Franklin Mfg. Co., Syracuse, N. Y., has joined the National Transit Pump & Machine Co., Oil City, Pa.

WILLIAM J. MAYER, formerly sales engineer for the Brockway Motor Truck Corp., New York City, has become assistant to the chief engineer of the Edward G. Budd Mfg. Co.

FRIEDRICH WILHELM LAMPE, formerly experimental and mechanical engineer of the Precision Balancing Machine Co., Minneapolis, Minn., has become experimental engineer in the Chevrolet experimental engineering laboratory of the General Motors Corp., in Detroit.

W. J. MCVICKER, formerly chief engineer of the threshers division, Moline Power Implement Co., Minneapolis, Minn., has become general manager of W. J. McVicker & Son, consulting engineers, of Minneapolis, engaged in designing agricultural, industrial and automotive machinery.

PAUL MILLER, previously engineer with the H. E. Dodge Boat & Plane Co., Detroit, has become engineer and designer for the Gray Marine Motor Co., Detroit.

DAVID A. NEMSER, chief metallurgist of the Pratt & Whitney Co., Hartford, Conn., discussed the heat-treatment and physical properties of high-speed steel before the Hartford chapter, A.S.S.T., recently.

CHARLES H. NORTON, awarded the John Scott medal by Franklin Institute for his invention of an accurate high-speed grinding device and some 100 other inventions, observed his eightieth birthday Nov. 23. He has been retired for some years.

DANIEL FELIX RITCHIE, formerly equipment sales engineer for the Allis-Chalmers Mfg. Co., at Springfield, Ill., has become designing engineer with the LaPlante Choate Mfg. Co., Cedar Rapids, Iowa.

CLIFFORD E. ROBERTS, formerly designer and checker of wings with the Glenn L. Martin Co., Middle River, Md., has become design engineer for military airplanes with the Consolidated Aircraft Corp., Buffalo.

RALPH N. ROBERTSON recently assumed the duties of chief engineer of the Atwood Bradshaw Corp., Pittsburgh. He was formerly connected with the Blaw-Knox Co. of the same city as mechanical engineer.

E. O. SESSIONS has formed the E. O. Sessions Co., Ltd., consulting engineers of 5022 Sheridan Road, Chicago, Ill.

ALLEN CONKLING STALEY is now serving as engineer in the research division of the Chrysler Corp., of Detroit, having relinquished his position of director of sales and engineering with the Climax Engineering Co., Chicago.

E. WALDO STEIN, who held the position of development engineer with the Firestone Tire & Rubber Co., in Akron, Ohio, has been made resident engineer for the company in Detroit.

HAROLD F. WOOD, who has been chief metallurgist of the Ingalls-Sheppard division of the Wyman-Gordon Co., in Harvey, Ill., since 1920, has been advanced to the post of works manager of that division.

WALLACE E. ZIERER now holds the position of experimental engineer with the Chrysler Corp., of Detroit. He formerly was engineering statistician with the same company.

NEW MATERIALS AND PARTS

and Engineering Equipment

"Inco" Chrome Nickel

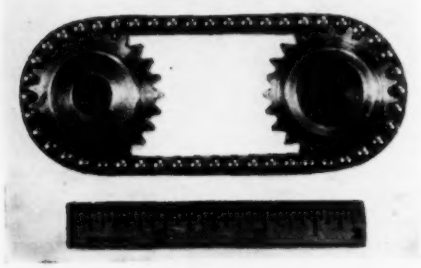
A non-ferrous alloy combining strength, resistance to corrosion and tarnish, and facility of manufacture has been announced by the International Nickel Co., 67 Wall St., New York, N. Y. This "Inco" chrome nickel is a nickel base alloy low in iron and containing chromium. It has shown high resistance to the tarnish of dairy products, brines and cleansing agents. It is being produced in the form of sheets, bars, tubes, and castings. In milk handling equipment, chrome nickel should be used in contact with milk cooling from the pasteurizing temperature to about 65 deg. F. The alloy combines the inherent corrosion resistance of nickel with surface stainlessness.

Link-Belt 3/16-In. Pitch Silent Chain

What is said to be the smallest silent chain drive has been announced by the Link-Belt Co., 515 Holmes Ave., Indianapolis, Ind. In appearance it compares with the Link-Belt silent chain, although it is too small to be made in the lined or bushed type. It uses an X-type pin.

The $\frac{3}{16}$-in. pitch chain is made in three types: middle guide, side flanged, and duplex. The middle guide and side flanged chains are employed where all shafts are driven in one direction, and duplex chains where reverse direction is desired on some shaft or shafts, or where adjustment features are required.

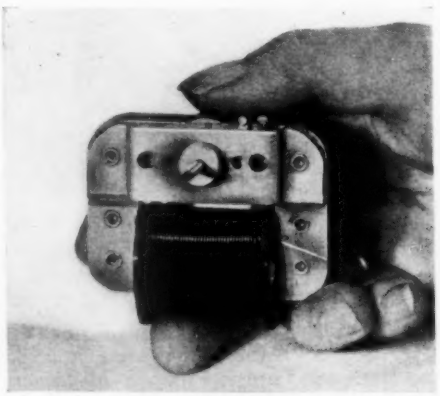
This chain has already been used as a transmission medium on such equipment as photo-tone machines, power cameras, television apparatus, regulators, meters, oil burners and similar equipment where a tiny positive drive is sought from a motor.



"Barcol" Small Size A.C. Motor

A fractional-horsepower electric motor, no larger than the palm of one's hand, and with unusually high power output for its size, is offered for commercial use by Barber-Colman Co., Rockford, Ill. Heretofore, the motor has been used only in the company's electrical products. The motor is furnished for either unidirectional or electrically reversible rotation, and is made for any voltage between 10 and 230, and for a.c. frequencies from 25 to 60 cycles.

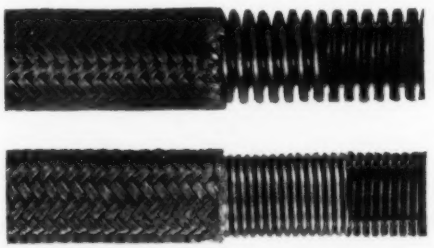
The motor is of the shaded-pole induction type and is constructed of



steel laminations, brass bearing plates with oilless bearings, and a skew-type squirrel-cage rotor mounted upon a hardened shaft. All coils are wound on phenolic-resin spools and are impregnated. Characteristics of the "Barcol" motor include relatively high torque, quiet operation, and absence of interference to radio reception.

American Seamless Flexible Tubing

Seamless flexible tubing, an improved type of flexible metal hose, is being offered by The American Metal Hose Co., Waterbury, Conn., for uses where incessive flexing is encountered, where material to be conveyed would affect the packing in ordinary metal hose fabricated from metal strip. and also where slight seepage through the packing of ordinary hose would be dangerous, particularly of penetrative liquids or gases. Being fabricated from seamless tubing, this hose is air-tight and leakproof. The accompanying illustration show a close-groove, wire-

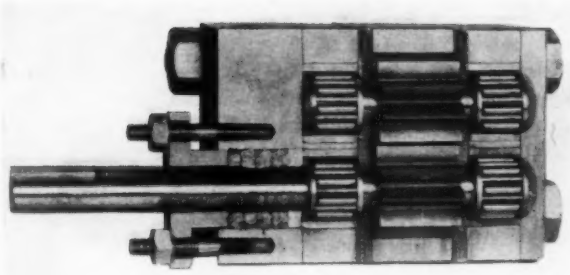


braided type of hose and an open-groove wire braided type.

While the tubing is suitable for moderate pressures without any outside protection, it can be used for extreme pressures when reinforced with one or more coverings of wire braiding. It is carried in stock in both flexible seamless steel and brass tubing in sizes ranging from inside diameters of $\frac{5}{32}$ to 2 in., but may be fabricated from various other alloys.

Northern XD Series Rotary Pumps

The next larger size of Nitralloy rotary pumps has been added to its line by the Northern Pump Co., Minneapolis, Minn. This XD series is of the same construction as the XA series, described on page 560, Vol. 74. The capacity ranges from 1 to 15 gal.



Northern XD Series Pump, which has a Nitralloy pumping chamber and roller bearings

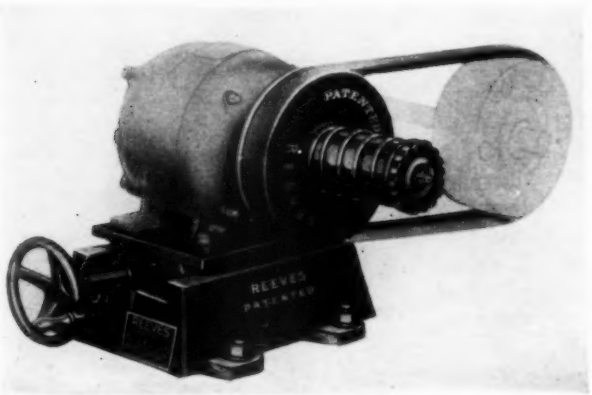
per min. Two types of bearing construction are available. Nitralloy bearings for supporting the pump shafts are used in pumps to handle fuel oil, coolant and any other liquid with little or no lubricating value. Roller bearings are incorporated in pumps for handling clean lubricating oil, especially for high pressure conditions such as 1,000 lb. per sq.in.

Reeves "Vari-Speed" Motor Pulley

The Reeves Pulley Co., Columbus, Ind., has recently developed a "Vari-Speed" motor pulley, a simple, compact speed-control unit, mounted directly on the motor shaft. The speed control is infinite over a 3:1 range, and is built in sizes up to 7½ hp.

The unit consists of two opposing cone-faced disks, one stationary and one sliding, and an adjustable power compression spring, all mounted on the motor shaft, a special motor base with adjusting handwheel, and a V-belt, forming connection between the disks and the driven pulley.

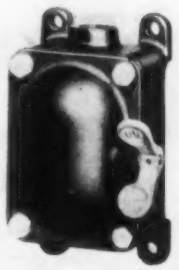
A turn of the handwheel in one direction moves the motor toward the driven pulley, and in the other direction, away from the pulley. This causes the V-belt to travel on a larger or smaller diameter between the disks, the sliding disk moving out laterally. Thus, the speed of the driven pulley is increased or reduced, effecting the speed change desired.



Sliding the motor in the belt plane moves the belt in or out between the separable pulley faces and changes the speed

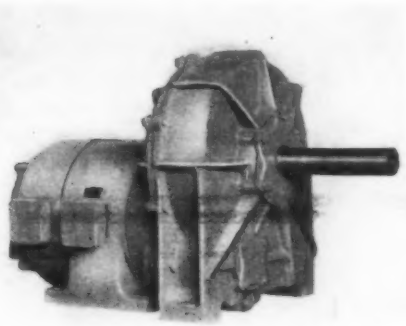
Square D Explosion-Proof Control Station

Class 9001, Type BR-11, explosion-proof control stations, manufactured by the Industrial Controller Div., Square D Co., Milwaukee, Wis., are approved by the Underwriters' Laboratory for Class 1, Group D, hazardous locations. The station is of the three-wire, momentary - contact type provided with one normally open and one normally closed contact inclosed in a cast-iron housing. Construction is such that the station will withstand an explosion.



Sterling "Slo-Speed" Motors

"Slo-Speed" motors, offered by the Sterling Electric Motors, Inc., Telegraph Road at Atlantic Blvd., Los Angeles, Calif., comprise the company's standard motors, the speed of which is reduced to a suitable low value by means of totally inclosed, single, double and triple helical or herringbone gears built into the motor frame. The gear wheels and pinions are of the stub-tooth type, and are made of special chrome-nickel steel. Thrust loads are arranged to equalize each other where more than one reduction is used. The housing is heavily ribbed and double oil seals are provided on the incoming rotor and outgoing power shafts to prevent oil seepage. Speed increasers are also available for speeds up to 6,000 r.p.m. Both the Slo-Speed and speed increaser units can be built on three-phase, squirrel-cage, slip ring, high-torque, 2-, 3- or 4-speed motors. Geared heads can



be put on both ends of the motor to provide two slow and different speeds, if desired. In most cases the gear bracket can be rotated 90 deg. or more.

Bristol Free-Vane Air-Operated Recorder

The Bristol Co., Waterbury, Conn., is offering a line of air-operated recording controllers employing a "free vane" as the initiator of control, which is a departure in instrument control. The free vane is attached

to and actuated by the measuring element of a temperature or pressure recording system and moves between two air jets with streamlines placed opposite each other. In passing into these air streams, the free vane varies the amount of air which escapes from the jets, thus effecting control.

NEW MATERIALS AND PARTS

"Lubrotite" Gate Valve

For general industrial equipment, the "Lubrotite" gate valve is being offered by the Reading-Pratt & Cady Co., Inc., Bridgeport, Conn. In this valve is provided a duct system for introducing a lubricant-seal between

the seating surfaces. The valve is sealed tight even though the seating surfaces have become damaged by scratches, deposits, or corrosion, and is therefore particularly suitable for chemical equipment. The valves are made in both the company's standard and extra-heavy iron body patterns, and in electric cast steel.

Cutler-Hammer Electric Space Heater

A Bulletin 15510 electric space heater, which is 2 ft. long, has been announced by Cutler-Hammer, Inc., 205 North 12th St., Milwaukee, Wis. This space heater has a heating element of nickel-chromium alloy, and a highly refractory granular compound is used for insulation. By imbedding the element in the compound under pressure, the space heater is made immune to vibration. The normal rated capacity is 500 watts, and units are furnished for 100-125 volts and 200-250 volts, either a.c. or d.c.

"E. C. & M." No. 2 Type ZO Motor Starter

A larger Type ZO across-the-line motor starter is being announced by the Electric Controller & Mfg. Co., 2700 E. 79th St., Cleveland, Ohio. Like the No. 1 starter, this new No. 2 unit is self-contained and totally inclosed in a pressed steel case with oil-immersed main and control circuit

contacts and vapor-proof overload relays. The unit is of compact design and dust-tight construction. It may be used for low-voltage release or low-voltage protection applications. Standard vapor-proof or explosion-proof push buttons can be supplied.

Square D Explosion-Proof Starters

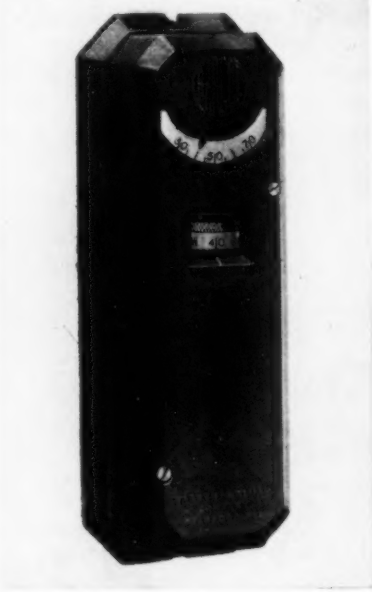
Class 8532, Types AR-1 and BR-1 explosion-proof starters, manufactured by the Industrial Controller Div., Square D. Co., Milwaukee, Wis., have been approved by the Underwriters' Laboratory for use in Class 1, Group D locations. Type AR-1 has a "start - stop" button in the cover, while the Type BR-1 is made for remote control.

The starter mechanism consists of a three-pole, magnetic contactor and thermal overload relays mounted on a porcelain base. An explosion-proof, cast-iron inclosure surrounds the starter mechanism.

The starters provide low-voltage protection and release, also time-limit overload protection to a.c. single and polyphase across - the - line motors. Maximum ratings are 1½ hp., 110 v., 3 hp., 220 v., single phase; 5 hp. 220 v., 7½ hp. 440-550 v., polyphase.

"Barcol" Indicating "Hygrostat"

A hygrostat, designed to meet the need for an inexpensive, well-constructed instrument for controlling humidifying apparatus by electrical means, has recently been added to the "Electric System of Temperature Control" of the Barber-Colman Co.,

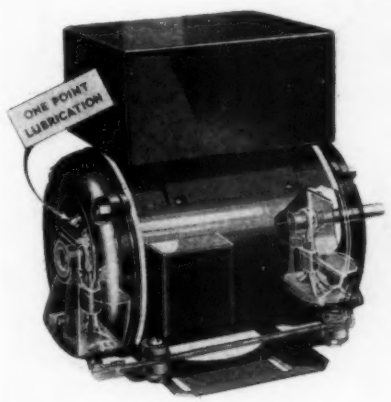


NEW MATERIALS AND PARTS

Rockford, Ill. This instrument is essentially an automatic two-way switch operated by changes in the length of a wood cylinder as it reacts to changes in atmospheric moisture content. The hygrostat not only actuates controlled mechanisms on a variation of less than 4 per cent in relative humidity, but indicates the existing humidity by means of a pointer and scale mounted in the instrument.

Howell Improved Refrigerator Motor

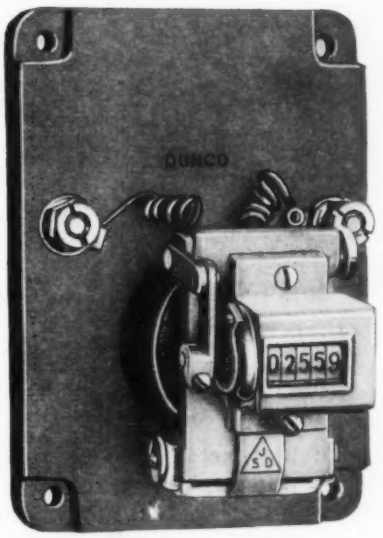
Automatic oiling is offered in connection with the fractional-horsepower, condenser-start, induction-run motor manufactured by the Howell Electric Motors Co., Howell, Mich. This feature comprises two oil wells,



one for each bearing, and each having a reserve capacity of 2 cu.in. of oil. This provides ample lubrication over an extremely long period of time. Each well is connected with the other at the bottom by a pipe line giving the advantage of one-point lubrication through the self-leveling feature. The design is non-spillable no matter in what position the motor is placed. Each sleeve bearing is wool yarn packed. The motor is particularly suitable for sealed-in installations, such as refrigerator motors.

Struthers-Dunn Electric Magnetic Counter

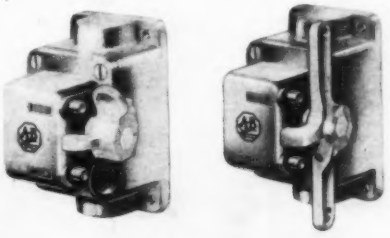
Both non-resetting and resetting types of the "Dunco" electric magnetic counter have been announced by the Struthers-Dunn, Inc., 146 No.



Juniper St., Philadelphia, Pa. These counters are designed and built on the same principles as the Dunco relays, featuring a standard armature, frame and coil with the counter added to the frame and mechanically connected to the armature, so that each impulse of the coil trips the counter. Up to 75 impulses per min. can be handled on the non-resetting type, while the resetting type can be actuated at 350 impulses per min., according to the application. Uses of this device include: in conjunction with a photo-electric cell; remote recording of production; vending machines equipped with electric contacts; remote counting of revolutions, and on any equipment where electrical contacts can be actuated. The unit is mounted on a base 3x4¼ in.

Allen-Bradley Water-Tight Pilot Control Stations

A line of water-tight and explosion-proof, push-button control stations, with levers for operation by finger, hand, foot, rope, or shipper rod, have been developed by the Allen-Bradley Co., 1311 S. First St., Milwaukee, Wis. The stations contain the A-B push-button mechanisms for either



standard-duty or heavy-duty service, inclosed in a cast-iron box with cover, all cadmium-plated, and tapped for ¾-in. conduit. The water-tight stations are provided with rubber gaskets. The cover and box of explosion-proof stations are machined to provide an explosion-proof seal without gaskets.

"Beetle" No. 212 Molding Compound

A lower-priced grade of "Beetle" molding powder is being marketed by the Synthetic Plastics Co., a subsidiary of the American Cyanamid Co., 535 Fifth Ave., New York, N. Y. The material is available in white and all other bright, translucent colors. It is a ureaformaldehyde molding powder without the troublesome thiourea, and is molded at a considerably faster rate than the older type, making it suitable for a wide range of low-priced parts.

"American" Small Flexible Coupling

Two small flexible couplings have been added to the line of the American Flexible Coupling Co., Erie, Pa. These couplings have maximum bores of ¾ in. and 1 in. and are designated as No. 4 and No. 6. In general design they are much the same as the larger couplings manufactured.

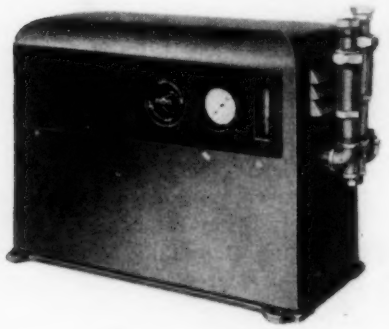
The flange sections are die-cast, and a wide groove is formed in the face to leave two jaws between which the

floating member slides. The floating center member is a solid, non-metallic, self-lubricating piece. Power capacity is 0.05 hp. per 100 r.p.m. for the No. 4, and 0.15 hp. per 100 r.p.m. for the No. 6. The weights are ¾ lb. and 2 lb. respectively. Both sizes permit a maximum parallel misalignment of $\frac{1}{64}$ in. and a maximum angular misalignment of 1 deg. It is not necessary to dismantle the coupling in order to disconnect the driving and driven shafts.

NEW MATERIALS AND PARTS

Logan Hydraulic Power Unit

A hydraulic power unit suitable for operating chucks, work-holding fixtures, clamps, hoists and the like is being offered by the Logansport Machine Co., Logansport, Ind. Pressure range is from 50 to 200 lb. per sq.in., and is adjustable through a regulating valve. The unit is for systems where a relatively small volume of fluid is necessary to do the work

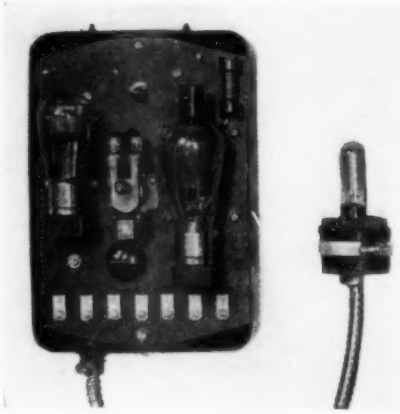


and where pressure must be maintained in the system for relatively long periods compared with the working interval.

In brief, the unit consists of a motor-driven constant-delivery internal gear pump, a spring-loaded accumulator, a pressure regulator and a pressure switch. Accumulator pressure is from 225 to 275 lb. per sq.in. When a pressure of 275 lb. is built up in the accumulator, the motor is cut out automatically; when the pressure drops to 225 lb. the motor is cut in again. Through this method of pressure control there is no by-passing of oil with consequent loss of efficiency.

General Electric High-Speed Photoelectric Relay

Photoelectric relay, CR-7505-G-5, introduced by the General Electric Co., Schenectady, N. Y., employs a Thyratron tube as a relay and finds its application in those operations where speed would be a limiting factor were a mechanical type relay employed instead of the Thyratron. Three electron tubes are used: a photoelectric tube which picks up the light impulse, a Pliotron tube which amplifies the electric impulse produced by the photoelectric tube, and a Thyratron tube which acts as a relay, producing properly timed impulses to operate electric devices either direct or through the medium of a contactor.



"Cleveland" Size 70 Worm Gear Reduction Unit

A Size 70 worm gear reduction unit to transmit up to about 7½ hp. has been developed by the Cleveland Worm & Gear Co., 3258 East 80th St., Cleveland, Ohio. The unit is furnished in both horizontal and vertical types. The horizontal units are built with the worm below or above the gear, and are designated as Type

AT or RT, respectively. In the Type VT vertical the gear shaft extends upward, and in the Type VD it extends downward. The Type AT is shown.

All shafts of this unit are mounted in anti-friction bearings. The worm and its shaft are made from a single nickel-alloy steel forging, and the gear is hobbed from a solid nickel-bronze blank. The worm thread is of the automotive type with a high-pressure angle. Oil seals are fitted on each shaft extenson. The nine standard ratios vary from 4 5/6:1 to 60:1, and fifteen special ratios are also available.

Cutler-Hammer Redesigned Manual Starters

Bulletin 9115 three- and four-pole types, across-the-line "X" manual starters have been redesigned to incorporate thermal overload relays in place of the thermal overload cutouts formerly supplied. The

starter is manufactured by Cutler-Hammer, Inc., 205 North 12th St., Milwaukee, Wis.

The overload relay provides many features not obtainable with the thermal cutout. Should an overload occur which may be dangerous to the motor, the overload relay trips, opening two lines to the motor so that the entire circuit is opened, preventing the motor's continuing to run on single-phase. When tripped, there is nothing to renew.

Square D Class 2510-W5 Starter

The Industrial Controller Division of the Square D Co., 710 South Third St., Milwaukee, Wis., has announced a Class 2510-W5 manual starter. This three-pole starter is designed to control across-the-line single and polyphase motors of 2 hp. or less. It is particularly applicable to machine tool

NEW MATERIALS AND PARTS

installations and suitable for general applications where remote control and low-voltage protection are not essential. Overload protection is provided by time-limit thermal relays which are front reset.

Link-Belt Variable-Speed Stoker Drive

A variable-speed drive is now being produced by the Caldwell-Moore plant of the Link-Belt Co., 2410 W. 18th St., Chicago, Ill., as a standardized drive for manufacturers of underfeed screw-type stokers. The drive is made in various sizes for

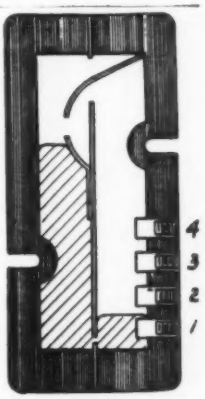
stokers ranging from 50 to 1,250 lb. per hour, coal feeding capacity.

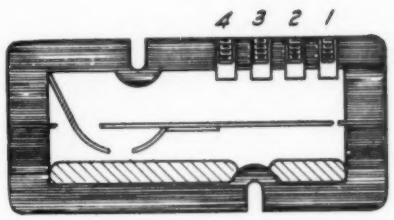
The first reduction is through an alloy steel worm and a bronze gear, with shafts mounted on anti-friction bearings. Final reduction is through the 3-speed adjustable ratchet, with overload shear pin hub, and full floating low-speed shaft. Speed changes are made through a single lever, without the use of a clutch.

Lincoln Time-Delay Switch

A time-delay switch, which is unaffected by temperature changes or by operating conditions, has been developed by the Lincoln Electric Co., Coit Road & Kirby Ave., Cleveland, Ohio. The principle of operation is the slow movement of mercury from one chamber to another, as shown by the sketches. The lower sketch shows the switch in the off position with the mercury in the lower chamber.

Wire connections are tapped to the upper compartment. In the upper view the switch has been turned on and the mercury has begun to flow into the other cavity through a small opening. As the mercury rises it completes the circuit at the various taps. By changing one connection to the different taps, a variation in time delay is secured. When the switch is turned off, that is, when it resumes its horizontal position, the mercury passes through a large opening into the lower chamber and the switch is ready again for use. Time delay ranges from 2 to 20 sec.





Crolite Low-Thermal Expansion Ceramic

The lowest coefficient of thermal expansion of any known ceramic is claimed for Crolite No. 7 ceramic, developed by Henry L. Crowley & Co., West Orange, N. J. This Crolite has a 4 to 1 advantage in thermal coefficient over sillimanite ceramic. The material is free from internal stresses and can be subjected to severe heat shock without cracking. Applications are to precision instruments, where changes of material must not upset the characteristics.

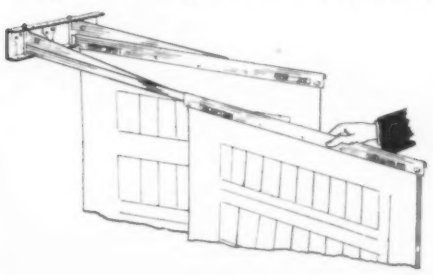
"M & P" Automatic Oiling System

An automatic oiling system that operates electrically without a pump or other moving parts has been developed by Motor & Plane Accessories, Inc., Detroit, Mich. It consists of an oil tank with a heater unit separated from direct contact with the oil. When the machine is to be lubricated, the Westinghouse electric

heater unit is turned on automatically. The temperature of the oil is raised and causes an expansion which forces oil out of the tank to the bearings where proper metering devices control the flow. After the temperature has reached 150 deg. F., a thermostat breaks contact and allows the oil to cool to 100 deg. At that temperature the thermostatic switch again makes contact. During the cooling process a vacuum occurs, which is utilized to refill the tank from a reservoir.

Acco Vertical Filing System for Blueprints

Quick accessibility to every blueprint is claimed for the vertical filing system developed by Acco Products Inc., Beebe Ave., Long Island City, N. Y. With this file it is possible, by using interchangeable units, to start



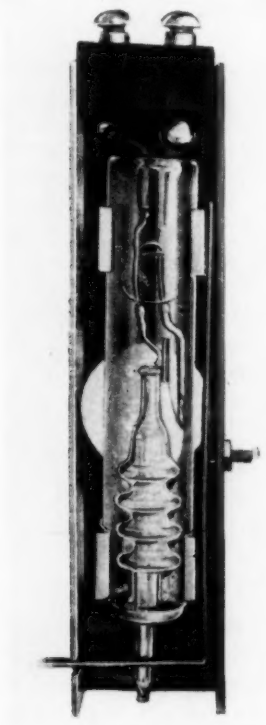
NEW MATERIALS AND PARTS

at small cost with only a single holder, having a capacity of 200 sheets, and to build up indefinitely by adding more holders. Holders are made for all sizes of sheets and in any capacity.

The holder contains a series of holes in two flanges, a hanger arm that is supported in the channel with a pin, and a sheet holder that slides on the track of the hanger arm and on which the sheets are secured. After being punched, the sheets are attached to the sheet holder.

Burgess Vacuum Contact Mounting

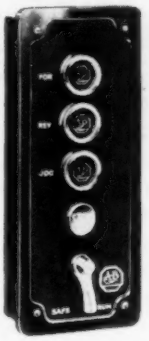
To facilitate the application of the Burgess vacuum contact to relays and other actuating mechanisms, a conveniently mounted unit has been developed by the Burgess Battery Co., 295 Madison Ave., New York, N. Y. The unit consists of a C-shaped metal casing to protect the glass vacuum



contact held in a pair of clips, a connecting link for coupling the actuating mechanism to the extension stem of the vacuum contact, and a pair of screw binding posts. An adjusting screw with locknut permits of applying counter pressure to the connecting link in offsetting the inherent spring tension that normally keeps the vacuum contact closed, when operating as an open circuit device.

Allen-Bradley Four- and Five-Button Motor Control Stations

The line of Bulletin 800 push-button control stations manufactured by the Allen-Bradley Co., 1311 South First St., Milwaukee, Wis., has been expanded by the addition of the type N-1060 series of 4-button stations having three running buttons, giving three motor speeds, and stop. The 5-button stations, known as the type N-1080 series, are for use with four-speed motors, giving four running speeds and stop position.



PUBLICATIONS

for the Engineer's Library

A.S.T.M. Standards. The American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa., has issued its 1931 edition of A.S.T.M. Tentative Standards, comprising 1,008 pages and containing 180 tentative standards. The volume also contains tentative revisions of 50 existing standards. Paper bound copies are available at $7.00, and cloth copies at $8.00.

Belt Drives. The Engineering Experiment Station of Ohio State University, Columbus, Ohio, has issued Bulletin 62 entitled "Belt Drives with Cast-Iron Pulleys and with Paper Pulleys." Investigation was made of the transmissive power of oak-tanned leather belts and rubber belts, particularly at small angles of contact, on the two types of pulleys. Twenty-five graphs are included in the text.

Chain. The Link-Belt Co., 501 No. Holmes Ave., Indianapolis, Ind., has issued a circular on its ⅜-in. pitch silent chain recently described. Illustrations of typical applications of this small chain are also provided.

Electrical Equipment. The General Electric Co., Schenectady, N. Y., has issued two publications as follows: Bulletin GEA-1516 on Type AB-1 inclosed air circuit breakers for 250 volts d.c., or 480 volts a.c.—15 to 200 amp., and Bulletin GEA-1522 on the type CR1062 motor-starting switch of the manual, across-the-line type—for small induction motors.

Iron Sheets. The Republic Steel Corp., Youngstown, Ohio, has just issued a 64-page booklet entitled "The Path to Permanence," giving latest information on Toncan copper-molybdenum iron sheets. It also gives a great many illustrations of various applications of this rust and corrosion-resisting sheet metal.

Molded Products. The Bakelite Corp., 247 Park Ave., New York, N. Y., has issued the fifth edition of its book entitled "Bakelite Molded," giving information on the resinoid itself, molding materials, the molding process and equipment therefor, and standard tests. Many typical Bakelite products are illustrated.

Motors. The Master Electric Co., Dayton, Ohio, has issued Data Book Section 210, on its geared-head motors for gear reduction or acceleration. The reduction or acceleration unit is built into the motor housing. Many typical products to which these geared-head motors have been applied are also illustrated.

Multi-Speed Drive. The Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has issued Leaflet L20520 on the Westinghouse-Wise multi-speed drive, which consists of an adjustable speed reducer built into a standard induction motor.

Recorder Controller. The Bristol Co., Waterbury, Conn., has issued Catalog No. 4001 on its air-operated recorder controller of the free vane type. The catalog gives views of the wall or flush type, a list of features, principle of operation, chart ranges, and suggested piping layouts.

Standards. The American Standards Association, 29 West 39th St., New York, N. Y., has issued a pamphlet entitled "Form and Arrangement of Published Standards," dated Nov. 25, 1931. The pamphlet comprises the report of the special committee which was appointed in January, 1925, to prepare recommended practices as a guide in the publication of standards.

Torque Motors. The Ohio Electric Mfg. Co., 5900 Maurice Ave., Cleveland, Ohio, has issued Bulletin 208 on "Slow Speed Torque Motors or Rotating Magnets," which have ability to stall across the line. Applications include closing and holding closed electrical contactors, valve stems and locking or clamping devices.

Valves. The Homestead Valve Mfg. Co., Inc., Coraopolis, Pa., has issued a new complete reference book on valves, containing 48 8½x11-in. pages.

Westinghouse Research. The Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has published a very attractive booklet entitled "Stories of Westinghouse Research," which illustrates and describes briefly the many lines of endeavor in which the company scientists have pioneered.

PRODUCT ENGINEERING

For Engineers and Executives Responsible for Product Creation, Design and Improvement

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Member A.B.C.
10,000 copies printed this issue

Published monthly. $2 per year, 25 cents per copy. Canada, $3.50, including duty. Foreign, $4.00 U. S. currency, or 20 shillings. Entered as second-class matter, January 17, 1930, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

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McGraw-Hill Publishing Company, Inc.
330 WEST 42d STREET, NEW YORK, N. Y.
CABLE ADDRESS: "MCGRAWHILL, N. Y."

CHICAGO - 520 North Michigan Avenue
SAN FRANCISCO - 883 Mission Street
LONDON, W. C. 2, Aldwych House, Aldwych

WASHINGTON - - - National Press Building
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